OBSERVATIONS

ON

SOME OF THE PHYSICAL, CHEMICAL, PHYSIOLOGICAL AND PATHOLOGICAL PHENOMENA

OF

MALARIAL FEVER.

BY

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INTRODUCTION.

THESE "Observations on some of the Phenomena of Malarial Fever," form the first of a series of observations which the author is conducting upon the fevers of the North American Continent.

The first three chapters are devoted to the consideration of the nature and extent of Pathological Investigations, and are intended as a general introduction to the whole series of investigations.

No one is more painfully alive to the imperfections of these incomplete observations than the author; and if they should result in inducing a single young man to enter this field, with correct views and the right spirit, he will feel that he has been rewarded for his labors.

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OBSERVATIONS ON SOME OF THE PHYSICAL, CHEMICAL, PHYSIOLOGICAL, AND PATHOLOGICAL PHENOMENA OF MALARIAL FEVER.

CHAPTER I.

RELATIONS OF MAN TO THE EXTERIOR UNIVERSE—RELATIONS OF ASTRONOMICAL, TERRESTRIAL, PHYSICAL, CHEMICAL, AND PHYSIOLOGICAL PHENOMENA—THE CHARACTER AND EXTENT OF PHYSIOLOGICAL AND PATHOLOGICAL INVESTIGATIONS ESTABLISHED BY THE RELATIONS OF MAN TO THE EXTERIOR UNIVERSE.

THE object of this chapter is to sketch the mutual relations of celestial and terrestrial bodies and animated beings, and demonstrate—that the existence of man is absolutely dependent upon the relations of the component members of the universe—that a single alteration in the chain of phenomena would destroy the conditions necessary for the existence and manifestation of the phenomena of man—that the forces of man are all resultants of the forces of the sun and fixed stars, which keep up a never ending circulation and change of matter upon the surface of our globe—that man cannot create or annihilate force any more than he can create or annihilate matter—that the great law of the Indestructibility of Force, of Action, and Reaction, applies to all the phenomena of man—that man is a type of the universe, and comprehends within himself all phenomena, astronomical, physical, chemical, physiological, and psychological—that the knowledge of the structure, phenomena, and relations of man includes a knowledge of all science, whether relating to matter or mind. The end of the whole investigation will be the establishment of the true character and extent of physiological and pathological investigations.

In this inquiry we will examine first the general or simple phenomena, and lastly the particular or complex.

There are certain phenomena, as gravity, which affect all bodies, and at the same time appear to be wholly independent, in their

existence and manifestation, of all other phenomena. These phenomena have been called[1] general or simple, because they appear to be not only independent in their own existence of all other phenomena, but they form the foundation of the manifestation and conditions of the existence of all other phenomena.

We have another class of phenomena which are confined to certain forms of matter, and whose existence and manifestation depend upon definite circumstances and the pre-existence of the general phenomena. These phenomena are called complex or particular. Thus the law of gravity, which (so far as our means of observation extend) affects every molecule of matter throughout the universe, is an instance of a general phenomenon; whilst physiological phenomena, which are manifested by only a comparatively small number of bodies, are instances of complex or particular phenomena.

General phenomena are wholly independent of the particular or complicated; whilst the particular or complicated are dependent upon the general, and cannot exist without them. Thus, we cannot conceive of matter without weight, but we do conceive and know of the existence of matter in a state of perfect freedom from the manifestation of physiological phenomena. It is evident that if we wish to understand the complex phenomena, we must analyze the component phenomena, and examine first the most general, which form the foundations of the existence and manifestation of the restricted or complex.

Man stands upon the summit of a pyramid, the foundation of which is the inorganic world, and the materials composing this pyramid consist: first, of plants in various stages of development, the simple extending downwards, the more complicated extending upwards, diminishing in numbers as they increase in complexity; and, secondly, of animals in various stages of development, increasing in complexity and diminishing in numbers as they extend upwards. To understand the physical and physiological constitution of man, we must commence at the base of the pyramid and examine successively all the elements, with their properties, forces, and constitution—we must examine the relations of the individual elements to each other and to the universe.

[1] That the true principles of the classification of the phenomena of the universe were recognized by the ancients, as well as by the moderns, is demonstrated by the fact that the historical development and classification of the sciences correspond with the logical classification. The principles of classification and the relations of the sciences have been discussed in a masterly manner by Auguste Comte in his Positive Philosophy.

Upon the present occasion we can do nothing more than present a general outline of this immense subject, for the complete knowledge of the intellectual and moral constitution of man alone requires the knowledge of the relations of the moral and intellectual faculties of man to the material structures by which they are surrounded—requires the knowledge of the relations of the moral and intellectual faculties to the physical, chemical, vital, muscular, and nervous forces—requires the knowledge of the nature, origin, and development of all science—requires the knowledge of the constitution, and phenomena, and progress of the moral and intellectual faculties as revealed in all history, scientific, civil, and religious, past and present.

If it be admitted that the art of medicine will attain to the rank of a science only when its relations with all the branches of knowledge are recognized and demonstrated, it must also be admitted that the present attempt to establish a standard for physiological and pathological investigations by the presentation of a general view of the relations of man to the exterior universe, incomplete and imperfect though it be, is an effort in the right direction.

In the survey of the universe all natural phenomena have been divided into two great classes, celestial and terrestrial.

Astronomical phenomena affect all bodies, whether they belong to this world or to the universe, and at the same time they may be said to be independent of all others. All bodies attract each other, in direct proportion to their masses, and in inverse proportion to the squares of their distances—this law, which is the sublimest of all generalizations, and the foundation of the science of astronomy, affects all bodies, inorganic and organic, inanimate and animate. The researches of astronomers are constantly enlarging our conceptions of the wide reign of the law of gravity. In every one of those wonderful binary systems of stars,[1] which have been suffi-

[1] The number of double stars (those both optically and physically double) observed by Sir William Herschel (1776—1804); by Otto Struve in Pulkowa (from 1813 to 1842); by Sir John Herschel (from 1819 to 1838); by Bessel; by Argelander at Abo (1827—1835); by Encke and Galle at Berlin (1836 and 1839); by Preuss and Otto Struve in Pulkowa (since the catalogue of 1837); by Madler in Dopart; by Mitchell in Cincinnati, U. S.; and by several other astronomers—may be estimated, with some certainty, at 6,000. The number of the double stars, the elements of whose orbits it has been possible to determine, is stated at present to be 16. History of the Royal Society, vol. iii., 1757, p. 225. An Inquiry into the Probable Parallax and Magnitude of the Fixed Stars, from the Quantity of Light which they afford us, by the Rev. John Mitchell, Philos. Trans., vol. lvii. pp. 234

ciently examined, the two systems are found to obey unswervingly Kepler's two laws, from which, by Newton's process, we infer that these grand orbs are held together by the force of gravity. The vast ocean of space and matter under the dominion of the force of gravity, even supposing it to be limited to these double suns, revolving around their common centres of gravity, is beyond all comprehension, for the light from many of these systems has to travel years and even centuries[1] before reaching our globe. A faint

—261. Outlines of Astronomy, by Sir John F. W. Herschel, Philadelphia, 1855, p. 475. Popular Astronomy, by Francis Arago, London, 1855, pp. 288—317. The Architecture of the Heavens, by J. P. Nichol, LL. D., London, 1851, pp. 165—268. Cosmos, a Sketch of a Physical Description of the Universe, by Alexander Von Humboldt, trans. by E. C. Otté, London, 1851, vol. i. pp. 136—139, vol. iii. pp. 271—289.

[1] Nichol's Architecture of the Heavens, p. 13.

Distances of the various orders of stars from our solar sphere.

Apparent magnitudes.	Distances of the exterior limit of the various orders expressed in radii of the earth's orbit.	Number of years occupied by light in traversing those distances.
1	1,246,000	19.6
2	2,111,000	33.3
3	3,151,000	49.7
4	4,375,000	69.0
5	6,121,000	96.6
6	8,746,000	137.9
7	14,230,000	224.5
8	24,490,000	386.3
9	37,200,000	586.7

According to astronomers the light of the most distant stars requires not merely centuries, but thousands of years to reach our globe. Our conception of the extent of the reign of the law of gravity is farther widened when we consider not only the immense distances of the stars from our earth, but also the immense orbits described by these double stars around their common centre of gravity, and especially the immense periods of time required for the completion of a single revolution.

The following table, illustrating the periods of revolution of these double stars, has been selected from Madler's extensive list:—

Stars.	Period of revolution in years.
210 Herculis	131
ξ Bootis	435
49 Cephi	466
ι Hydræ	584
1 Leonis	561
42 Ceti	696
1 Cassiopeiæ, 1 pair	1,065
" 2 pair	2,785
γ Leonis	1,342

conception of the immensity of the distance may be formed, when we reflect that light passes over 191,515 English miles in one second. The grand march of our sun, with his attendant planets, through the great ocean of space, at the annual rate of 154,185,000 miles,[1] around a distant unknown centre, supports still more strongly the conclusion, that all the particles of matter in the universe are mutually related. Without this fixed relation of all the individual and component molecules of the universe, matter could not exist in its present condition. Destroy the mutual attraction of bodies, and the essential conditions for the existence of the universe will be destroyed. The existence of this law is independent of all others, and of every form, property, and affection of matter; whilst all the properties and affections of the various forms of matter, inorganic or organic, depend ultimately upon the existence of this fixed relation of the molecules of matter. If our sun with his planets were blotted out of existence, this fixed relation of the remaining molecules of matter would not be destroyed. If sun after sun, and system after system, were blotted out of existence, it is reasonable to believe that this law would not be destroyed as long as two atoms of matter remained.

The atoms of matter are bound together by a force which acts only at insensible distances, called the force of cohesion. It has been announced by some philosophers that the force of cohesion is nothing more than the force of gravity, acting between the individual atoms of bodies, at exceedingly small distances. Be this as it

Stars.	Period of revolution in years.
γ Ceti	1,478
α Piscium	2,928
ζ Coronæ	3,542
ψ Cassiopeiæ	5,468
Polaris	6,069
ζ Ursæ Majoris	7,659
γ Andromedæ	10,376

The periods occupied by the motions of sun around sun are exceedingly various, some occupying but a brief and rapid cycle of fifteen or sixteen years, and others occupying thousands; whilst in others the changes are so slow that they are almost imperceptible, and betoken circuits of immense spaciousness and duration.

[1] J. F. W. Herschel's Outlines of Astronomy, p. 494. Arago's Popular Astronomy, p. 363. Bessel in Schum, Jahrb. für 1839, s. 51. Arago in the *Annuaire*, 1842, pp. 388—399. Argelander, On the Proper Motion of the Solar System, 1837, s. 43. Otto Struve in the Bull. de l'Acad. de St. Petersb., 1842, t. x., No. 9, pp. 137—139. Nichol's Architecture of the Heavens, p. 242. Humboldt's Cosmos, vol. i. p. 134.

may, it is evident that if matter be deprived of these two forces of cohesion and gravitation, its properties of form, color, porosity, compressibility, dilatability, and elasticity, would cease to exist, and the manifestation of its peculiar affections or motions, as heat, light, electricity, and magnetism, would be impossible. Without these properties of matter no organized plant or animal could exist in any portion of the universe, constructed upon the same plan with those of our globe.

When we turn our eyes from a general survey of the universe to our own system, we discover that its present state depends absolutely upon the mutual relations of its component parts.

Mathematicians, reasoning upon the necessary results of the law of gravity in producing mutual disturbances in the motions of the planetary bodies, came to the conclusion that our system contained within itself the elements of its destruction. They thought that they could demonstrate that derangement must ensue from the mutual action of the heavenly bodies upon each other—they thought that they could calculate its progress with the utmost exactness, and predict the time when the whole system would be destroyed by the action of the law of gravity, which, when first discovered, appeared to be the great principle of motion and stability. The fallacies of these calculations and falsity of these prophecies have been exposed by the sublime discoveries of Lagrange and Laplace, which have shown that the relative distances, sizes, orbits, and periods of revolution of the planets are so nicely adjusted that the mutual perturbations counterbalance each other, so that, amidst numberless conflicting, disturbing, destructive influences, unity, harmony, and stability result.

The order and harmony of our system give unmistakable evidence of the working of one great omnipotent mind. The plan of each planet is the type of the whole system. Thus, all the planets revolve around the sun in the same direction, from west to east, which is the direction of the rotation of the sun on his axis; all the planets rotate on their axes also in the same direction, all the satellites move around the primaries in the same direction, and almost all the planets and satellites move around the sun in nearly the planes of the sun's equator. From these arrangements it results that they all have the succession of day and night, and vicissitudes of the seasons. As far as the observations of astronomers have extended, it appears that the planets are constructed and arranged upon the same plan with our earth. The surface of one is diversi-

fied with mountains, valleys, and plains—another is surrounded by an atmosphere apparently having analogous motions (trade-winds) to those of our own atmosphere—the surface of the red colored Mars is divided into green seas and red continents, and as his winter advances a white color spreads over his northern regions, and as summer approaches this whiteness disappears, thus showing that a fluid exists upon his surface, which, like water, is congealed by cold, and dissipated by heat—and many of them have their satellites, which, like our own moon, rule the night. It is not reasonable to suppose that the blazing sun should shine by day, and the gentle satellites by night, upon mere dead masses of matter moving forever silently and fruitlessly through space. These beautiful arrangements force upon us the belief that the members of our solar system are inhabited by beings, which, probably, from the very arrangements themselves, are analogous to those inhabiting our globe.[1] If they be inhabited by similar beings, the existenee of these inhabitants must depend absolutely upon the mutual relations of the component members of the system.

The truth of this assertion is evident when we consider the relations of the organized beings inhabiting our globe to the size, density, and structure of the earth, and to its relations with the sun and all other members of our system.

The plants and animals of our globe have all been constructed with exact reference to its structure, its mass, its power of gravity, and the forces of the sun and sister planets. If the mass, and density, and force of gravity of our earth were increased, the density of the atmosphere would be correspondingly increased, and the respiration and circulation of animals and plants would be greatly interfered with, if not completely arrested—the rise of the sap in plants, which is due to the physical force of endosmose, which in this case acts antagonistically to gravity, would be counterbalanced and completely checked, and the elaboration of the sap, and the nutrition and growth of plants, absolutely prevented—the muscular strength of animals would be inadequate to the continued support and active movement of their bodies; the swiftest animals would crawl like sloths; and the once active and energetic lords of creation, instead of directing and controlling the powers of nature,

[1] "Discourses on the Christian Revelation viewed in connection with the Modern Astronomy," by Thomas Chalmers. "The Plurality of Worlds." "More Worlds than One," by Sir David Brewster. "The Unity of Worlds and of Nature," by the Rev. Baden Powell.

would drag out miserable existences, moving as if under heavy burdens, exhausted by the slightest mechanical effort. On the other hand, if the mass and force of gravity of our planet were greatly diminished, the atmosphere would be correspondingly rarified—the respiration, and circulation, and nutrition of animals and plants disturbed—the development of their physical and chemical forces retarded and disturbed, and their situation and motions rendered unstable.[1]

The relations of the moon with our earth are of the most important character. Her influence is not confined to ruling the night, lighting the mariner and traveller, and exciting joy in the hearts of all by her soft and silvery beams. The weight of the moon and her distance from the earth have been appointed by the great Architect with exact reference to the size and density of our globe, its distance from the sun, its relations with other planets, and the constitution of its atmosphere and crust, and the structure, forces, and wants of plants and animals.[2]

The distance of the earth from the sun has been arranged with exact reference to the structure of the surface, and the constitution and preservation of its organized beings. Were the distance of the earth from the sun increased or diminished, or the inclination of the plane of its orbit increased, or the nearly circular orbit rendered as eccentric as the orbit of a comet, the alternations of seasons, the climate, and constitution of many bodies upon the

[1] "Astronomy and General Physics considered with reference to Natural Theology," by Rev. William Whewell, D. D.

[2] If the moon had been placed much nearer the earth, or had been much larger than it is, the tides of the oceans would have run so high that large tracts of land would have been uninhabitable, and navigation rendered dangerous, if not impossible.

We may form some idea of the influence of the moon upon this earth, by considering the fact, that, owing to its proximity to the earth, the agency of the moon in producing tides in the waters of the oceans, and in the atmosphere, is from $2\frac{1}{4}$ to $2\frac{1}{2}$ times greater than that of the sun.

The rise of the tide not only aids greatly navigation, by its repeated flow into numerous harbors, rivers, and creeks, which would, on account of their shallowness, be useless for the purpose of navigation, but it also diffuses the saline ingredients of the oceans, washed from the strata at their sides and bottom, and from the continents through which the rivers flow, and thus maintains the purity and uniformity of the waters. Without this perpetual agitation, it is probable that the waters of the oceans would become unfit for animal and vegetable life.

The attraction of the sun and moon produces corresponding tides in the great ocean of gaseous matter surrounding our globe. These motions in the atmosphere must, without doubt, exert decided influences upon organized beings.

surface of our globe, would be greatly altered, and the chemistry of organized beings deranged. The sun is a great centre of chemical as well as of physical influences, and should he be blotted out of existence, or if the intensity of these chemical and physical influences be lessened or increased, either by an actual diminution or by a change of the distance from the sun to the earth, not a vegetable or animal could exist upon this globe, because the sun's heat and chemical influences are absolutely indispensable to the growth and existence of plants. If vegetation be destroyed, as a necessary consequence all animal life, with its chemical compositions and decompositions, must cease, because animals, whether herbivorous, or carnivorous, or omnivorous, derive the materials for the nutrition of their structures, and the development of the forces which work their machinery, ultimately from vegetables.

The sun, and all the countless fixed stars of the material universe, are the sources of the heat which preserves matter in its present conditions upon the face of our globe, and supplies the essential conditions for the existence of organized beings.[1]

[1] The states of matter, solid, fluid, and gaseous, are relative and not absolute. The existence of matter in one or the other of these states depends upon the forces acting upon the atoms. The atoms of matter are not in immediate contact with each other. The distance of the atoms from each other, and the stability of the matter which they form, depend upon the action of two antagonistic forces, cohesion and heat. Heat corresponds to the repulsive centrifugal force, and cohesion to gravitation, the attractive centripetal force. According to this view a particle of matter is a type of our solar system; it is composed of smaller bodies, held in definite positions and accomplishing definite movements by two apparently antagonistic forces. In the solid state the attractive cohesive force is stronger than the repulsive force of heat. In the fluid state, whilst the attractive force preponderates over the repulsive, the two are more nearly balanced, and the polarity of the particles is overcome, and they are movable in all directions, and transmit forces equally in all directions. In the gaseous state the repulsive force, heat, is stronger than the attractive cohesive force, and the particles have lost their polarity. The existence, then, of matter in one or the other of these states depends upon the temperature. As far as our means of observation extend it may be asserted that all the various forms of matter may be made to assume these states successively by a variation of the temperature. Thus, the metals are solids at ordinary temperatures. When heat is applied they become fluid, and if the heat be continued they become gaseous. Many of the gases have been reduced first to fluids, and secondly to solids, under a reduction of temperature and increased pressure.

One of the essential conditions of all animals and vegetables is that they possess a large amount of fluid. Without this fluid the important acts of circulation, nutrition, secretion, and excretion, and the preservation of a definite form during unceasing chemical compositions and decompositions, could not be maintained. If animals and vegetables be deprived of fluid, all motions amongst the individual molecules must cease.

The fixed stars, although analogous to our sun, are at so great distances that it seems unreasonable to attribute to them any influence over the changes going on upon the surface of our globe. When, however, we consider that scarcely a line can be projected into space from any point upon our globe without eventually striking one of these suns—when we consider that in some places many thousands appear to be gathered into a space no greater than that occupied by the disk of the full moon, it will be no longer a matter of surprise that they should exert a decided influence upon the temperature of our globe.

M. Pouillet,[1] from an elaborate series of experiments upon solar and stellar heat, finished in 1838, drew the following remarkable conclusions:—

1. That the actual temperature of space in which the earth and planets move lies between —175° and —283° Fahr.

2. That the sun supplies the earth annually with as much heat as would melt a layer of ice 100 feet thick, covering the entire globe.

3. That the fixed stars supply as much heat as would melt a layer of ice 85 feet thick, covering the whole globe.

According to this calculation, the solar heat alone constitutes only two-thirds of the entire quantity of heat supplied to the earth, to repair its losses by radiation into space. If this calculation be true,[2] it is evident that if the heat supplied by the fixed stars be

[1] Memoir on the Solar Heat, on the Radiating and Absorbing Powers of the Atmospheric Air, and on the Temperature of Space, by M. Pouillet, Member of the Royal Academy of Sciences of Paris, Professor of Natural Philosophy in the Faculty of Sciences, &c. Comptes Rendus des Séances de l'Académie des Sciences, July 9, 1838. See Translation in Taylor's Scientific Memoirs, 1846, vol. iv., article iii. pp. 44—90.

[2] Whether these conclusions of Pouillet be true or false, they are sustained by the researches of the best observers, in that they agree in assigning to the regions of space a definite temperature. Thus, Fourier,* from a careful series of investigations, estimates the temperature of space at from —58° to —76°; Arago,† from polar observations, at —70°, and Pictet at —76°; Saigey, from 367 observations made by Humboldt in the chain of the Andes and in Mexico, at —85°, and from thermometrical measurements at Mount Blanc and during the aeronautic ascent of Gay-Lussac, at —107; Sir John Herschel‡ at —132, and Poisson§ at only 8°.6.

* Théorie Analytique de la Chaleur, 1822, p. ix. (Annales de Chimie et de Physique, tom. iii., 1816, p. 350; tom. iv., 1817, p. 128; tom. vi., 1817, p. 259; tom. xiii., 1820, p. 418.)

† Arago, Sur la température du pôle et des espaces célestes, Annuaire du Bureau des Long, pour 1825, p. 189, et pour 1834, p. 192; also Saigey, Physique du Globe, 1832, pp. 60—76.

‡ Edinburgh Review, vol. 87, 1848, p. 223.

§ Poisson, Théorie Mathematique de la Chaleur (§ 196, p. 436, § 200, p. 447, and § 228, p. 521, § 227, p. 520). See Analysis of the Mathematical Theory of Heat, by S. D. Poisson, in Taylor's Scientific Memoirs, vol. i., article vi., 1837, p. 122.

withdrawn, the physical structure of the surface of our globe would be changed, the greatest portion of the ocean would become a crystalline mass, and all animals and plants would be destroyed.

These results of Pouillet, considered in connection with the grand march of our sun, with his attendant planets, through space, throw much light upon those wonderful geological revolutions which show that regions now covered with ice and snow were once covered with the rank vegetation of the tropics. It has been supposed with reason that our system, in its majestic travels through the great ocean of space, has swept into the blazing heat and light of some of those splendid suns. At such a period there would have been a grand illumination and distribution of heat from pole to pole, and the icebergs, and glaciers, and snow of polar regions would be succeeded by the luxuriant vegetation of the tropics.

It is evident that if the rays of the sun and stars possessed no heat, or if the distance from the earth to the sun was greatly increased, or the stellar radiation greatly diminished, all the various forms of matter would be reduced to one form, the solid, and as a necessary consequence all vegetable and animal life would be destroyed. The solid state is as essential to the existence of organized beings as the fluid state. If the distance from the earth to the sun was greatly diminished, the heat would be correspondingly increased, and all solid bodies would be reduced to fluids, and, if the heat be sufficiently intense, to gases—the whole structure of organized beings would be deranged, because the solid materials, which give individuality to the structures, the organs, tissues, and apparatus of plants and animals, would be transformed into unstable fluids.

All the motions in the atmosphere, and in the water, and upon the land, are resultants of the combined actions of the sun and fixed stars, and the forces of matter composing the globe. An alteration of the intensity or direction of one or the other class of forces, will necessarily be attended by a corresponding alteration of the structures and motions of inorganic and organic bodies.[1]

[1] The truth of these propositions can be readily established by the consideration of the most important properties and motions of the gases, fluids, and solids of our globe, and their relations to animated beings.

The atmosphere, like all gases, is capable of indefinite expansion under a diminution of pressure or increase of heat, and of indefinite contraction under an increase of pressure or diminution of heat. It is perfectly elastic, and the particles

Upon the property of bodies to expand when under the influence of heat, and to contract when deprived of heat; and upon the property of light gases and fluids to ascend through the more dense; upon the rapidity and direction of the earth's revolution on its axis; and upon the structure of the earth's surface (the relations of land and water with reference to the absorption and radiation of heat), depend the motions in the atmosphere called the trade-winds and land and sea-breezes, and the corresponding currents in the ocean. If the atmosphere and ocean had been so constituted that currents were not excited by heat, they would have been stagnant, motionless—the cool sea-breezes, loaded with moisture, which in the heat of summer revive the drooping vegetation, and at all seasons of the year waft the mariner's ship along, would never have existed—the trade-winds, the great movers of commerce, would have been unknown—mankind would have been confined to the continent on which they were created, because the ocean would have been stagnant, without current, and navigation would have been impossible—the surface of our globe would have been a barren desert, supporting trees only along the borders of the ocean.

The existence of animated beings is absolutely dependent upon the constitution and mutual relations of the atmosphere and watery vapor, and the supply of a definite amount of heat. The evaporation of water continuously from the whole surface of the oceans, lakes, rivers, continents, and islands, and the distribution of the watery vapor through the atmosphere, require an immense expenditure of mechanical force.[1]

are self-repellent as long as they are acted upon by the mechanical force, heat. The repellent force of the atoms of the atmosphere and of all gases is nothing more nor less than the heat of the sun. Just in proportion as this is removed the particles obey the attractive force and approach each other, and it is probable that if all the heat was removed the atmosphere and all gases would become as solid as the framework of the continents and mountains.

[1] The spaces between the atoms of the atmosphere are devoid of matter, and are freely penetrable by the atoms of other gases. When gases come in contact, a process of rapid diffusion through the pores of each other takes place, and a uniform mixture is established. Water, when changed from the fluid to the gaseous state, possesses all the properties of a gas, and rapidly diffuses itself through the vacant spaces between the atoms of the atmosphere. The amount of the watery vapor varies with the intensity of the repellent force, heat. As long as the repellent force, heat, acts with sufficient intensity to overcome the attractive force of the earth, the watery vapor will manifest all the properties of the atmosphere. The force which excites a motion in the atmosphere will excite a corresponding motion in the watery vapor. As the existence of the watery vapor depends upon

The sun and the fixed stars are the sources of the heat or mechanical force which keeps up a never-ending circulation of water throughout the atmosphere and over the surface of our globe. Some idea of the agency of heat in the phenomena of our globe may be formed by taking the water which falls upon its surface as an evidence of its mechanical power. If we take 60 inches as the average annual amount of water which falls in the form of rain, dew, hail, and snow, upon the surface of the earth, and 900 feet as the average height from which it falls, then the work of the falling water would equal 452 horse-powers upon each square mile of the earth's surface, and the work accomplished upon the whole surface of the earth would equal the enormous sum of 90,880,000,000 horse-powers. If the united powers of all the steam engines of all the nations of the earth be estimated at seven millions of horse-powers, then the work accomplished by the solar and stellar heat, in merely evaporating and elevating the water from the surface of our globe, would be 12,982 times greater than that which could be accomplished by all the steam-engines of the world, supposing them to work continually day and night. The immense volumes of water flowing in the rivers of the earth existed first in the ocean, then in the atmosphere in the form of vapor. The mechanical power of the water flowing in these rivers may be taken as an index of the force which raised the water from the surface of the ocean, and transported it across immense continents. It has been calculated that the waters of the river Niagara, during their passage over the cataracts and falls, exert a mechanical power equal to 12½ million horse-powers. The mechanical power of the Niagara River alone, is greater than that of all the steam-engines of the world. The

the supply of a definite amount of heat, it is evident that its existence is conditional, limited, whilst that of the atmosphere is stable, unconditioned, during all the changes of temperature with which man is conversant. Whenever the repellent force is so diminished that it is unable to overcome the attractive force between the atoms, the vapor is transformed into water, and is deposited in the form of rain, dew, mist, snow, and hail.

The conversion of water into vapor is accomplished by the expenditure of an immense amount of heat, which may be stated in round numbers to be one thousand degrees. This heat has no effect upon the thermometer, because it has been transformed into mechanical force, and is occupied in keeping asunder the atoms of water. By the law of inertia that force is indestructible, and by the law that action and reaction are always equal, this heat will be given out again when the particles approach each other. This being the case, we may say with truth that water requires for its evaporation an immense expenditure of mechanical force.

Niagara, in comparison with the Mississippi, Amazon, La Plata, Yenisei, Yang-Tse, Nile, Hoan-Ho, and many others, is only a modest, medium sized river. After we have calculated the immense mechanical power of the mighty volumes of water flowing in the fountains, brooks, torrents, streams, and rivers of the earth, we have formed but an imperfect idea of the effects upon our globe of the two great forces, gravitation and heat, which influence all heavenly bodies, and work throughout the entire universe, for, according to the calculation of Pouillet, forty per cent. of heat is absorbed during its passage through the atmosphere, and immense quantities are expended in expanding and maintaining currents in the ocean and atmosphere.

The water elevated by heat, during its descent upon the earth, and passage back to the oceans from whence it came, dissolves and wears down the solid mountains and continents. The solid rocks are disintegrated, the mineral matters are dissolved, stones and masses of rock are loosened from hill-sides, even the very mountain peaks are undermined by the trickling water, and every fountain, every brook, every mountain torrent, and every river transport these materials, and gradually fill up the lakes, and seas, and oceans, and build up immense deltas and islands. This everlasting round of the waters, carried on by heat and gravitation, prepares the surface of the barren rocks for the habitation of plants and animals, and tends to level every mountain and fill up every depression upon our globe.

The structure of the crust of our globe gives unmistakable evidence that in its early history it was a molten mass. When the surface cooled it was composed of nothing but rocks and water, a dead barren mass, studded with volcanoes and lofty rocks. Geology teaches that at this time no plant or animal existed upon our globe. It was necessary that the solid barren rocks should be disintegrated, worn away, the inequalities of the surface filled up, and the crust of the earth covered by a loose, pulverized soil, suitable for the habitation of plants and animals. This was accomplished by the circulation of the water and air, under the action of heat and gravitation, which at the present day preserves the purity of the ocean and atmosphere, waters the thirsty earth, supplies the most important elements of the structures of plants and animals, and clothes the surface of the earth with a luxuriant vegetation, which elaborates the materials for the formation and maintenance of all animals, from the simple animalcule to the complicated organism of man.

The immense mountain ranges and table lands, which influence, to a great extent, the climate of continents, and exert an effect upon the structure, and growth, and distribution of plants and animals, and determine, in a great measure, the habits, occupations, and diseases of man, have all been elevated by those forces, which rocked our earth in its cradle, raised up the mountains, brought low the valleys, heaved up immense continents, and divided the sea from the main land.[1]

To the superficial observer, the angry strife between the great forces of heat and gravitation—the blazing volcanoes, belching forth burning lava, and deluging the fertile valleys and plains with a fiery flood—the earthquakes, rocking the globe, fracturing and rolling up its strata, heaving up immense continents from the ocean's bed, removing the pillars of broad tracts of land and plunging them far into the bosom of the earth, would appear to be under the guidance only of blind, mad fate, chained and struggling in the fiery bowels of the earth. It is, however, true that even this fiery

[1] The irresistible energy of the force of heat is displayed by the discharges of gas, steam, mud, and melted lava from the craters of volcanoes, and by the earthquakes which have caused our globe to tremble from pole to pole. On the 19th of November, 1822, an earthquake was felt along the eastern coast of South America, for the space of 1200 miles from north to south. The whole country, from the foot of the Andes to a great distance under the sea, was elevated from two to seven feet. One hundred thousand square miles of land, an extent of country almost equal to the States of Georgia and Alabama, was elevated, at the lowest calculation, three feet. According to the estimate of Sir Charles Lyell, the thickness of the rock between the surface of Chili and the subterranean foci of volcanic action may have been many miles in depth. If the thickness be estimated at two miles, then the mass elevated three feet was 200,000 cubic miles, and equalled in weight 363 million pyramids.

The discharge of mud in one year by the river Ganges equals the weight of sixty pyramids. It would require 17½ centuries before this river could bear down from the continent into the sea a mass equal to that gained by the South American continent during a single earthquake.

In the great eruption of Skaptara Jokul, in Iceland, the volcano threw out a torrent of lava, which flowed down the sides of the mountain into the Skaptara River, completely dried it up, and not only filled the channel of the river, which was between high rocks, and in many places from 400 to 600 feet in depth, but overflowed to a great extent the surrounding country, expanded over wide alluvial plains, and formed broad, burning lakes, fifteen miles in breadth, and one hundred feet in depth. The streams of lava were ninety miles in length, and from seven to fifteen in breadth, and from 100 to 600 feet in depth. If we add to this the pumice, sand, and ashes scattered not only over the whole island, but to a distance of 300 miles around, in such abundance as to destroy the fisheries in the neighboring sea, the whole amount of matter ejected by the volcano would be millions of cubic yards.

strife is under the guidance of an intelligence who brings unity out of diversity and discord, harmony and order out of contending forces and elements, life and fertility out of fire and destruction. Every earthquake which in past or present times has fractured and dislocated the solid strata of the earth, elevated the bed of the ocean, or depressed the level of the continents—every volcano which has poured forth the liquid contents of the interior of the earth—every flood which has swept over the ancient continents, has contributed more or less to the formation of a suitable soil for the maintenance of plants and animals, and the development of the human race.

The forms, arrangements, and distributions of the terrestrial masses, although the results of the action of the forces of heat and gravitation, reveal a great design.

Every form of matter is definitely related to every other form of matter upon the face of the globe; and the combination of these various relations, and actions, and reactions of terrestrial masses form the essential condition for the manifestation of the great designs of the Creator.

It is a universal law that all the component parts of the universe do not have in themselves the entire aim or reason of their existence.

The history of nations has been, in a great measure, determined by the agency of heat and gravity upon matter. As man is composed of inorganic elements, and governed by all the laws, physical, chemical, and astronomical, which govern the exterior world, it follows as a necessary consequence that the peculiar constitution and relations of the inorganic elements of the crust of our globe must affect the physical and mental endowments of man. The solid portion of our globe is constructed for man just as the body is made for the soul. The physical and mental development of the different races of mankind has depended, in great measure, upon the mutual relations of the solid and fluid portions of our globe. This has been demonstrated by a comparison of the physical characters of the great continents of our globe with the physical, social, and intellectual development of their inhabitants.[1]

[1] "The continent of Africa is without any great rivers, peninsulas, and bays. It is concentrated upon itself, and nowhere lets into its bosom the waters of the sea.

"Africa has a sea-coast of only 14,000 geographical miles, whilst it covers an area of 8,720,000 square miles.

"Africa has only one mile of coast for 623 miles of surface. It is like a body

The chemist, by decomposing, analyzing, and comparing together the different forms of inorganic and organic matter, has demonstrated that the innumerable forms of matter, rocks, and minerals, plants and animals of all colors and shapes, result from the combinations of sixty-two simple bodies, which cannot be resolved into any other elements. These elementary bodies unite with each other in definite quantities by volume and weight, and each body has its own combining weight, which, together with the manifestation of the physical forces during chemical combination, appear to depend upon the size and arrangement of the ultimate atoms.

During the union of these elementary bodies the physical forces, heat, light, and electricity, are manifested in amount exactly corresponding to the number and arrangement of the elementary bodies combining. Whilst each separate substance has its own color, form, density, gravity, cohesion, elasticity, and its relations

without arms. Its relations with other continents are few and imperfect. It closes itself against every influence from without.

"Without large rivers, without harbors and bays, without peninsulas, it offers but few facilities for commerce, the great medium of the interchange of the thoughts of nations.

"The intellect of the African, like the physical constitution of the continent on which he lives, is shut up to itself; it is circumscribed by definite boundaries; it is incapable of active relations with surrounding intellects.

"Of all the continents, Europe is the one whose forms of contour are most varied. Its principal mass is deeply cut in all parts by the ocean and by inland seas, and seems almost on the point of resolving itself into peninsulas. These peninsulas themselves, as Greece, Scandinavia, repeat to infinity the phenomena of articulation and indentation of coasts which are characteristic of the entire continent. The inland seas, and the portions of the ocean its outer limits inclose, form nearly half its surface. The line of its shores is thus carried to the extent of 17,200 miles, an enormous proportion compared with its small size; for it is 3,200 miles more than the sea-coast of Africa, which is, nevertheless, three times greater.

"Europe enjoys one mile of coast for every 156 square miles of surface. Thus, it is the continent most open to the sea for foreign connections, and at the same time it is the richest in local and independent districts.

"In Europe we find the greatest number of independent organized kingdoms, the greatest variety of interests, and the most continued and rapid intercourse. For 2,000 years Asia has lost the sceptre of power and civilization, and Europe stands unquestionably the first of the civilizing continents. Nowhere on the surface of our planet has the mind of man risen to a sublimer height; nowhere has man known so well how to subdue nature and make her the instrument of his intelligence.

"The nations of Europe, including the Anglo-American branch, represent not only the highest intellectual growth which the human race has attained at any epoch, but they rule already every part of the globe, and are preparing to push their conquests farther still."—"*The Earth and Man*," by Arnold Guyot, p. 30.

to heat, electricity, magnetism, light, and chemical affinity, still these properties, and the manifestation of these physical and chemical phenomena, are similar in all bodies, differing in degree and not in kind.

In view of the recent discoveries of science, with reference to the equivalents of the physical forces, we believe that we are justified in asserting that an equivalent of force is always given out during the combination of the elementary bodies corresponding to that required to separate those bodies from their compounds (overcome the force which united the dissimilar elements), whether that force be exerted in the laboratory of the chemist by heat or by electricity, or by bringing other chemical affinities into play; or in the laboratories of plants and animals, or in the great laboratory of nature, by the action of the heat and chemical forces of the sun.

In the exertion of every force in the universe, whether between the great worlds and systems of worlds, or between the atoms of matter, inorganic and organized, whatever be the origin, character, or intensity of that force, the great mechanical law holds good. Action and reaction are equal. The physical and chemical motions, or affections, or forces of matter, mechanical motion, heat, chemical affinity, and electricity, are correlative; that is, they can mutually excite, or be converted into each other.[1] Whatever hypothesis we

[1] In the cells of the galvanic battery we have a chemical action developing a physical force or motion (electricity), which may be propagated from particle to particle of an insulated wire, of any length; and if the wires propagating the electrical excitement be dipped in water or any compound fluid, a chemical action will be developed, the extent of which will correspond with the chemical action going on in the cells of the battery.

If the bodies separated from each other by the electrical excitement be united, an equivalent of force will be given out corresponding to the force required to produce their separation. The force generated during their union may be applied to the expansion of the water in the boiler of a steam-engine, and thus accomplish mechanical effects. Here we have chemical action developing electricity, and this in turn developing chemical action, and the union of the products of that chemical action giving out an amount of force equivalent to that developed during the chemical changes in the cells of the battery.

If the wires conducting the electrical excitement, instead of being immersed in a fluid, be united by a metal which is a bad conductor (or, in other words, retards the passage of the electrical excitement), heat will be developed in amount corresponding to the retardation of the electrical excitement.

The development of heat by friction is considered by philosophers as the conversion of motion of masses into motion of the component atoms. In the electrical machine we have the development or excitation of electricity by ordinary impeded

adopt, whether of actual conversion, or of excitement of the different forces—the law of action and reaction holds good as far as the researches of philosophers have extended, because if there be not an actual conversion of one force into another, it is always true that the force exciting is diminished in an amount corresponding to the excitement of the second force. The direction of a force may be changed, it may be subdivided and directed in so many directions, and assume so many different modes of force or motion, as to escape our observation, or it may be held in abeyance by opposing force, just as the action of the steel spring is counterbalanced by the force of gravity of a weight; but it can no more be destroyed than matter.

The three great fundamental laws of motion established by Kepler, Galileo, and Newton:—

1. A body at rest cannot of itself begin to move; and a body in motion cannot change its velocity nor its direction of motion without the action of some extraneous cause; any body impelled by a single force will move in a right line and with uniform velocity.

2. Independence or coexistence of motions leading to the composition of forces.

3. Constant equality of action and reaction; one body moving another body loses precisely as much motion, in proportion to its mass, as the body moved gains; although applied by them to mechanical motions alone, are applicable to all the motions and forces, astronomical or terrestrial, of the masses or atoms of inanimate and animate bodies.

The establishment of the truth of these laws for all motions and forces, however excited, is necessarily followed by the admission that, as far as the powers of finite beings extend, force is indestructible. The store of force with which the Creator has endowed matter can neither be added to nor detracted from by man, any more than he can add to or detract from the store of matter. Without this mutual relation of all the different forces, without the conservation of force, the universe would not be maintained in its present condition.

motion. Electricity may be generated also by the revolution of the keeper of a magnet around the poles of the magnet.

The action of the steam-engine, and of the locomotive apparatus of every animal, demonstrates the correlation of chemical affinity, heat, and mechanical force.

The application of these laws to physical and chemical phenomena, and the establishment of this wide generalization, has not been the work of one mind alone, but of many minds, in different countries, often working entirely independent of each other. The human mind, from the earliest periods, endeavored to explain the origin and order of the universe, and discover some general principle or origin of all things. The early students of nature, the founders of the ancient schools of philosophy, endeavored to divine, at a single glance, the whole import of the book of nature, and discover the origin and principle of the universe. The ancient Hindoos, Sabians, Chinese, Persians, and Egyptians worshipped deities which were resolvable into the powers of nature, and were mythological personalities of the sun or solar fire. Thales, Parmenides, Archelaus, Democritus, Pythagoras, Hippocrates, and many other ancient philosophers, maintained the existence of an omnipresent fiery æther, as the efficient and primary cause of motion throughout the universe, by the energy of which matter was reduced to order from chaos, and life infused and maintained in plants and animals. Notwithstanding the dimness and vagueness of these cosmogonies, which were better suited to the dim magnificence of poetry than to exact science, the human mind at the present day adopts a view of the physical universe which, if more exact, is certainly not more grand.

Whilst the ancient philosophers failed to establish the exact relations of phenomena, because they neglected to a great extent experiment and analysis of phenomena, and did not form definite and distinct ideas for each class of facts, still their general systems and cosmogonies were based upon observation of nature, and were partial expressions of great philosophic laws. Thus the reference of all motion and of all life to the light and heat of the sun, was without doubt founded upon the actual observation of the relations of the sun to plants and animals, and corresponds to the teachings of modern science, that the Creator has constituted the sun the source of motion, sensation, and life upon our globe.

Modern science differs from ancient philosophy, in that it penetrates beyond general views, decomposes the phenomena into its component facts, and points out the separate forces of the sun and terrestrial masses, and the relations of these forces, to each other and to the different forms of matter, inanimate and animate.

In the history of the correlation of the physical forces, we have

a history of the origin and development of the different departments of physical and chemical science.

In mechanics and astronomy, the establishment by Archimedes of the doctrine of the lever and some important properties of the centre of gravity, and the fundamental propositions of hydrostatics —the observation of the most striking phenomena—the formation of the notion of a year and month, and the fixation of the year and month and of the seasons—the invention of lunisolar years—the observation of the most general phenomena presented by the constellations and planets—the distribution of the places and motions of the heavenly bodies by means of a celestial sphere with imaginary lines drawn upon it—the promulgation of the doctrine of the globular form of the earth by Anaximander, and the demonstration of this doctrine by Aristotle—the erection of the dial by Anaximenes and Anaximander—the attempt of Aristarchus to measure the distance of the sun as compared with that of the moon—the establishment of the theory of epicycles and eccentrics by Hipparchus—the exposition of the theory of epicycles and eccentrics and of the observations and calculations which were employed in order to apply this theory to the sun, moon, and planets, and the discovery of evection by Ptolemy—the formal promulgation of the heliocentric theory by Copernicus—the application of the telescope to the examination of the heavenly bodies, the discovery of the satellites of Jupiter and of the ring of Saturn, and the verification of the Copernican theory with regard to the motion of Venus by Galileo —the establishment by Kepler of numerical and geometrical laws connecting the distances, times, forces and velocities of the bodies which revolve about the central sun—the revival of the idea of pressure and the demonstration of the equilibrium of oblique forces, which includes the principle of the composition of statical forces by Stevinus—the establishment of the first law of motion (a body acted on by one force will move forever in a straight line with uniform velocity), the application in mechanical science of the notion of accelerating force, the establishment of the second law of motion (curvilinear motions), and of the principle of virtual velocities, and of the third law of motion, by Galileo—the confirmation of the laws of falling bodies, by the experiments and reasonings of Gassendi, Fermat, Riccioli, and Grimaldi—the labors, experiments, reasonings and generalizations of Bacon, Descartes, Castelli, Huyghens, Hooke, Halley, Mersenne, Bernoulli, Hermann, Leibnitz, Euler, Clairaut, D'Alembert, Lagrange, Gassendi, Borelli, and other

philosophers: all prepared the way for the development of those facts and fixed relations or laws, which formed the great Newtonian induction of universal gravitation, expressive of the truth that every particle of matter in all times, places, and circumstances is definitely related to every other particle of matter in the universe, by one common law of attraction, which must be pronounced, in whatever light it be viewed, whether in the immensity of the knowledge and labor which it involved, or the extent and bearing of the truth which it discloses, as the greatest scientific discovery, as a law which in generality and profundity and magnificence stands without a rival and without even a comparison. Whilst the facts which most nearly concerned Newton in the establishment of the law of gravitation, were the facts of the planetary motions as established by Kepler, and of the moon's motions as given by Tycho Brahe and Horrox, it is nevertheless true that the facts included in this law had been accumulating from the very foundation of astronomy, because it included every fact, discovery, and law, and included in one vast magnificent generalization the immense detail of astronomical science.

In optics, the experiments, labors and reasonings of Seneca, Ptolemy, Archimedes, Euclid, Alhazen, Vitello, Snell, Gregory, Descartes, De Dominis, Newton, Huyghens, Grimaldi, Biot, Arago, Hooke, Young, Fresnel, Brewster, and others, have resulted in the establishment of the undulatory theory, which in its simplicity and universality bears the same relation to optics that the law of gravitation bears to astronomy. Whether we consider light as an undulation of a thin all-pervading ether, or of ordinary matter, the conclusion is the same, that it is a peculiar kind of motion or mode of force, and as such bears a definite relation to the other modes of force. Thus Professor Faraday has established the existence of a relation between light and magnetism, and the relations of heat and light have been observed and studied by many investigators, and modern investigations have demonstrated that an intimate relation exists between light and chemical affinity.

In acoustics, the labors and discoveries of Pythagoras, Mersenne, Newton, Taylor, Bernoulli, D'Alembert, Euler, Lagrange, Laplace, Poisson, and others, have established the undulating theory of sound. According to this theory sound is a vibration or motion of ordinary matter, the character of which is dependent upon the number and arrangement of the atoms.

In thermotics the theory of Bacon,[1] Locke,[2] and others, that heat is motion, has been confirmed, enlarged, and extended to the varied phenomena of heat, by the experiments, observations, and reasoning of Rumford,[3] Davy,[4] Leslie,[5] Dulong,[6] Clausius,[7] Mayer,[8] Magnus,[9] Holtzmann, Regnault,[10] Rankine, Thompson, Joule,[11] and others.[12]

[1] "From the instances taken collectively, as well as singly, the nature whose limit is heat appears to be motion. * * p. 161.

"What we have said with regard to motion must be thus understood when taken as the genus of heat; it must not be thought that heat generates motion, or motion heat (though in some respects this be true); but the very essence of heat, or the substantial self of heat, is motion and nothing else, limited, however, by certain differences," p. 165.

"The form or true definition of heat (considered relatively to the universe and not to the sense) is briefly thus: heat is an expansive motion restrained, and striving to exert itself in the smaller particles. The expansion is modified by its tendency to rise through expanding towards the exterior; and the effort is modified by its not being sluggish, but active and somewhat violent. With regard to the operative definition, the matter is the same. If you are able to excite a dilatory or expansive motion in any material body, and so to repress that motion and force it on itself as not to allow the expansion to proceed equally, but only to be partially exerted and partially repressed, you will, beyond all doubt, produce heat; without any consideration whether the body be of earth (or elementary, as they term it), or imbued with celestial influence, luminous or opaque, or dense, locally expanded, or contained within the bounds of its first dimensions, verging to dissolution, or remaining fixed, animal, vegetable, or mineral, water, or oil, or air, or any other substance whatever susceptible of such motion. Sensible heat is the same, but considered relatively to the senses," p. 171.—*Novum Organum, or True Suggestions for the Interpretation of Nature*, by Francis Lord Verulam. London, William Pickering, 1850.

[2] "Heat is a very brisk agitation of the insensible parts of the object, which produces in us that sensation, from whence we denominate the object hot; so what in our own sensation is heat, in the object is nothing but motion."—John Locke.

[3] The first approximate numerical determination of the connection between heat and mechanical force (the mechanical equivalent of heat) was made by Count Rumford. His experiments had for their object the determination of the relation existing between the force and time expended in boring a brass cylinder, and the amount of heat developed by the friction.

"It appears to me," Count Rumford remarks, "entirely difficult, if not quite impossible to form any direct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in these experiments, except it be motion." One of the most important points in his account of these experiments, is the estimate of the quantity of mechanical force required to produce a certain amount of heat. According to Count Rumford, the heat required to raise a pound of water 1° F. is equivalent to a force represented by 1034 foot-pounds. This estimate is too high, because no account was taken of the heat dissipated during the experiment.—"An Inquiry concerning the Power

of Heat which is excited by Friction," by Count Rumford, *Phil. Trans.*, vol. lxxxviii., 1798; *Phil. Trans.* abridged, vol. xviii. p. 286.

[4] Sir Humphrey Davy communicated a paper to Dr. Beddoe's West County Contributions, entitled "Researches on Heat, Light, and Respiration," in which he confirmed the views of Count Rumford, by melting two pieces of ice, rubbed against each other in the vacuum of an air-pump, which was kept below the freezing point. From this experiment Davy drew the inference that "the immediate cause of the phenomena of heat is motion, and the laws of its communication the same as the laws of the communication of motion."—See *Elements of Chemical Philosophy*, p. 94.

[5] Experimental Inquiry into the Nature and Propagation of Heat. London, 1804.

[6] The researches of Dulong on the specific heat of elastic fluids established the fact that "equal volumes of all the elastic fluids taken at the same temperature and under the same pressure, being compressed or dilated suddenly to the same fraction of their volume, disengage or absorb the same absolute quantity of heat." *Mémoires de l'Académie des Sciences*, t. x. p. 188. This law, established by the researches of Dulong, is of the greatest importance in the development of the theory of heat, because it proves that the calorific effect is under certain conditions proportional to the force expended.

[7] "Ueber die bewegende Kraft der Warme," Pogg. Ann. lxxix. 394. Ueber die Art der Bewegung welche wir Wärme nennen, von R. Clausius, Pogg. Ann. c. 353. On the Application of the Mechanical Theory of Heat to the Steam-Engine, by R. Clausius. The American Journal of Science and Arts, vol. xxii. p. 360; vol. xxxii. p. 25.

[8] Experiment on the Evolution of Heat by Fluid Friction. Annalen of Wœhler and Liebig, May, 1842.

[9] "Experiments on the Expansive Force of Steam," Poggendorff's Annalen, No. 2, for 1844; see Trans. in Taylor's Scientific Memoirs, vol. iv. p. 218. On the Force Requisite for the Production of Vapors, *ibid.*, No. 2.

[10] "On the Elastic Forces of Aqueous Vapor," Annales de Chimie et de Physique, July, 1844; Taylor's Scientific Memoirs, vol. iv. p. 559. Hygrometrical Researches, Comptes Rendus, t. xx. pp. 1127 and 1220, April, 1845. Taylor's Scientific Memoirs, vol. iv. p. 606. Phil. Mag., vol. xx. p. 111.

[11] In 1843, Joule showed that the heat evolved by magneto-electricity is proportional to the force absorbed; and that the force of the electro-magnetic engine is derived from the force of chemical affinity in the battery, a force which otherwise would be evolved as heat; from these facts he announced that the quantity of heat capable of increasing the temperature of a pound of water by 1° F. equals and may be converted into a mechanical force capable of raising 838 pounds to the perpendicular height of one foot.—*Phil. Mag.*, vol. xxiii. p. 441.

In a subsequent paper, read before the Royal Society in 1844, Joule showed that the heat absorbed and evolved by the rarification and condensation of air is proportional to the force evolved and absorbed in these operations; and the quantitative relation between force and heat, deduced from these experiments, is almost identical with that derived from the electro-magnetic experiments.—*Phil. Mag.*, vol. xxvi. pp. 375—379.

In 1843, Joule announced that heat is evolved by the passage of water through narrow tubes.—*Phil. Mag.*, vol. xxiii. p. 442; xxvii. p. 205; xxxi. p. 173.

In an article "On the Mechanical Equivalent of Heat," published in the Philosophical Transactions of the Royal Society, part 1, 1850, p. 61, Joule announced as the results of an extended series of experiments:—

Volta's immortal discovery demonstrated the relation between electrical and chemical phenomena; the decomposition of water by Nicholson, in 1800, revealed the chemical energy of electricity, and constituted the starting point of electro-chemical research; the brilliant discoveries of Davy[1] demonstrated the close relation, if not the identity of chemical affinity and electricity; the labors of Becquerel established the synthetical influence of electricity; the profound and extensive researches of Faraday,[2] following up the

1. That the quantity of heat produced by the friction of bodies, whether solid or liquid, is always proportional to the quantity of force expended.

2. That the quantity of heat capable of increasing the temperature of a pound of water (weighed in vacuo, taken at between 55 and 60°) by 1° F. requires for its evolution the expenditure of a mechanical force represented by the fall of 772 pounds through the space of one foot.

[12] Memoirs on the Free Transmission of Radiant Heat through different Solid and Liquid Bodies, by M. Melloni, Taylor's Scientific Memoirs, vol. i. pp. 1—74, p. 325, p. 388. The Mathematical Theory of Heat, by S. D. Poisson, Annales de Chimie et de Physique, vol. lix. p. 71, *et seq.* See Analysis, in Taylor's Scientific Memoirs, vol. i. p. 122. Memoir on the Motive Power of Heat, by E. Clapeyron, Taylor's Scientific Memoirs, vol. i. p. 347.

Kupffer, by comparing the expansion which a metal wire suffers by heat with the elongation produced by stretching it with a given weight, found that the heat necessary to raise a pound of water 1° F. is equivalent to 661 foot-pounds. Phil. Mag. [4], xli. 393. Kronig on the "Fundamental Principles of a Theory of Gases," Pogg. Ann., xcix. 315. "Investigations on Radiant Heat," by H. Knoblauch, Taylor's Scientific Memoirs, vol. v. 188—383. "On the Heat and Elasticity of Gases and Vapors, and on the Principles of the Theory of Steam-Engines, by C. Holtzmann, Manheim, 1845. See also Taylor's Scientific Memoirs, vol. iv. p. 189.

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[1] In September, 1800, Sir Humphrey Davy published his first paper, describing experiments similar to those of Nicholson and Carlisle on the decomposition of water.—*Nicholson's Journal*, 4to. iv. 275.

In 1802, Davy conjectured that in all cases of chemical decomposition the elements might be related to each other as electrically positive and negative, and in 1806 he attempted the solution of this question, and after referring to his experiments of 1800, 1801, and 1802, and to a number of new facts, which showed that oxygen, alkalies, and acids, and oxidizable and noble metals, were in electrical relations of positive and negative, he drew the conclusion, "that the combinations and decompositions by electricity were referable to the law of electrical attractions and repulsions," and advanced the hypothesis "that chemical and electrical attractions were produced by the same cause, acting in the one case on particles, in the other on masses; and that the same property, under different modifications, was the cause of all the phenomena exhibited by different voltaic combinations." —*Phil. Trans.*, 1826, p. 389.

[2] "On the Induction of Electric Currents; the Evolution of Electricity from Magnetism; a New Electrical Condition of Matter; Arago's Magnetic Phenomena." Phil. Trans., 1831. "Terrestrial Magneto-Electric Induction; Force and Direction

discoveries of Oersted, Davy, Arago, and Schweigger, demonstrated the identity of the chemical, electrical, and magnetic forces, and led this great philosopher to advance the idea that the so-called imponderable bodies are merely the exponents of different forms of force.

The researches of Petit,[1] in 1722, on the effect of light upon the crystallization of saltpetre and sal-ammoniac, and the analysis of the action and demonstration of the chemical influences of the rays of light, by Charles William Scheele,[2] confirmed and extended by the researches of Senebier,[3] Count Rumford,[4] Méese,[5] Priestley,[6]

of Magneto-Electric Induction," Bakerian Lecture, Jan. 12, 1831. Identity of Electricities derived from different Sources; Relation by Measure of Common and Voltaic Electricity, 1833. Electro-Chemical Decomposition, 1833 and 1834. Nature of the Electric Force or Forces; Relation of the Electric and Magnetic Forces; the Current its Forces, 1838. On the Source of Power in the Voltaic Pile, 1840. On the Electricity Evolved by the Friction of Water and Steam against other Bodies, 1840. On the Magnetization of Light and the Illumination of Magnetic Lines of Force, 1845. On New Magnetic Actions, and on the Magnetic Condition of all Matter, 1845. On the Crystalline Polarity of Bismuth (and other bodies), and on its relation to the Magnetic form of Force, 1850. On the possible relation of Gravity and Electricity, 1850. On the Magnetic and Diamagnetic Condition of Bodies, 1850.

For these and many other papers by Professor Michael Faraday, see Philosophical Transactions for 1831—1852. These papers have been collected and published in three volumes—vol. i., 1849, sec. ed.; vol. ii., 1844, first ed.; vol. iii., 1855. In his Bakerian Lecture for 1845, Professor Farraday stated his views of the relations of the forms of force, thus:—

"I have long held an opinion, almost amounting to conviction, in common with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have one common origin; or, in other words, are so directly related and mutually dependent that they are convertible, as it were, into one another, and possess equivalents of power in their action. In modern times the proofs of their convertibility have been accumulated to a very considerable extent, and a commencement made of the determination of the equivalent forces."

[1] "Sur la Végétation des Sels," Mém. de Paris, 1722.

[2] Scheele, Traité de l'Air et du Feu.

[3] Senebier sur la Lumière, tom. iii. p. 199.

[4] "On the Propagation of Heat in Fluids," Phil. Trans. "An Inquiry concerning the Chemical Properties that have been attributed to Light," Phil. Trans., 1798.

[5] B. C. Méese, in 1775, first published experiments upon the influence of light on plants.

[6] In 1779, Dr. Priestley determined the problem of vegetable respiration, and showed that carbonic acid was absorbed by the plant, that under the influence of light it was decomposed and its oxygen liberated. Experiments and Observations on Different Kinds of Airs and other Branches of Natural Philosophy, Birmingham, 1790. See also Senebier, Expériences sur l'Action de la Lumière Solaire dans la Végétation, Paris, 1788.

Ingenhousz,[1] Saussure,[2] Ritter,[3] Wollaston,[4] Young,[5] Vogel,[6] Herschel,[7] Seebeck,[8] Gay-Lussac, Thenard, Berard, Wedgwood,[9] Niepce, Daguerre,[10] and Draper,[11] have resulted in the establishment of the complex nature of the sunbeam, and the demonstration of the relations of light, heat, chemical affinity, and animal and vegetable life.

The names which we have mentioned by no means form a complete list of those who have assisted, by their observations, experiments, reasonings, and teachings, in the establishment and promulgation of the doctrine of the mutual relations of the physical and chemical forces.

In 1808, Oken[12] affirmed that "light could be nothing but a polar tension of the æther, evoked by a certain body in antagonism with the planets; and that the heat was none other than the motion of this æther;" and in his "Physiophilosophy"[13] not only points out,

[1] "Expériences sur les Végétaux," Phil. Trans., 1782.

[2] "Recherches Chimiques sur la Végétation," Annales de Chimie, vol. i.

[3] Gehlen, Journal der Chem., vol. vi.

[4] Philosophical Transactions, 1802, p. 379.

[5] Phil. Trans., 1804.

[6] Annales de Chimie, vol. lxxv.

[7] Transactions of the Royal Society of London, 1800.

[8] Philosophical Magazine, vol. vii., 2d ser., p. 462.

[9] An Account of a Method of Copying Paintings upon Glass, and of making Profiles by the Agency of Light upon Nitrate of Silver, with Observations, by H. Davy, 1802.

[10] History and Practice of Photogenic Drawing, by M. Daguerre, translated from the original by T. S. Memes, LL. D. London, 1839.

[11] Philos. Mag., Sept., 1841.

[12] Erste Ideen Zur Theorie des Lichts, der Finsterniss der Farden und der Wärme, Jena, bey Frommann, 1808.

[13] "Magnetism and electrism are correlated, as iron and sulphur, as gravity and light, as centre and periphery. The same spirit, which, when ruling in the dark, exhibits itself as magnetic, is manifested when it has attained to light in sulphur as electrical. Magnetism is only the electrical identified. We may, therefore, speak of idiomagnetic metals as well as idioelectric bodies. Magnetism, therefore, stands in opposition to electrism; they mutually change or annihilate each other. p. 167. * * Chemism is related to magnetism as salt is to metal, as the sedimentary to the primary periods. The whole sedimentary period is a product of chemism, as the whole primary period is the product of magnetism." * *

Magnetism and chemism are thus the creating agents for the solid nucleus of the earth, and through both it is completed. The process of earth formation is magneto-electrism. Regarding the earth as an entire crystal, magnetism is the determinant of its polar axis and polar radii, while chemism is the same in respect to its integral parts. All terrestrial action is an interchange of these two functions or souls, which are none other than the living gravity, and the living light upon

but bases much of his theory of the evolution and order of the world upon the mutual relations of gravity, light, electricity, magnetism, heat, and chemical action.

Carnot, in 1824, in his researches upon heat, attempted to establish the relations of the physical forces.

Lardner Vanuxem[1] (an American), in the year 1827, published a work, in which he affirmed that caloric, light, electricity, and magnetism are convertible one into another, and are but different states of one kind of repulsive matter.

In 1833, Dr. Metcalfe, in an essay entitled a "New Theory of Terrestrial Magnetism"[2] (subsequently expanded[3] into his magnificent work on caloric), traced the most striking analogies of caloric and electricity, and endeavored to show that they are radically the same subtle, imponderable, and all-pervading element, and that its unequal distribution through nature is the cause of all the various forces and attractions of ponderable matter with which man is acquainted.

the planet. The electricity, like the heat, only maintains them in eternal tension or extension.

Chemism is the process of space, density, quiescent heat, therefore the latent heat, or the temperature, must change in every chemical process.

Chemism is related to magnetism as heat to gravity, to electricity like as to light.

Crystallization is point, magnetism line, electrism surface, chemism cube. Elements of Physiophilosophy, by Lorenz Oken, M. D.; translated for the Ray Society from the German, by Alfred Tulk, pp. 176—177. London, 1847.

Coleridge maintained that electricity, galvanism, and magnetism, are the fundamental principles of action in nature, and that "a power acting exclusively in length is (wherever it be found) magnetism; that a power which acts both in length and breadth, and only in length and breadth, is (wherever it be found) electricity; and, finally, that a power which, together with length and breadth, includes depth likewise, is (wherever it be found) constructive agency."—*Hints towards the Formation of a more Comprehensive Theory of Life*, by S. T. Coleridge. Philadelphia, 1848.

[1] An Essay on the Ultimate Principles of Chemistry, Natural Philosophy, and Physiology, by Lardner Vanuxem. Philadelphia, 1827.

[2] "Caloric, electricity, and galvanism have hitherto constituted a separate and distinct triad of imponderables, perfectly incomprehensible; all the phenomena of which are quite intelligible, if we refer them to the agency of one grand, primary, universal element," p. 27.

[3] This article was extended, published in a series of articles in the Knickerbocker Magazine for 1834—5, and finally expanded into that great work, which will ever remain as one of the noblest monuments of American learning and philosophy. Caloric, its Mechanical, Chemical, and Vital Agencies in the Phenomena of Nature, by Samuel L. Metcalfe, M. D. London: William Pickering, 1843.

Dr. Samuel Jackson,[1] in his Introductory Lecture for 1837, asserted that "physical phenomena, according to the class to which they belong, are referred to a few simple laws, as gravity, caloric, affinity, galvanism, electro-magnetism, all of which, it can now be scarcely doubted, are manifestations of one great force." This learned teacher and philosopher has for one quarter of a century taught from his chair in the University of Pennsylvania, not only the correlation of the physical forces, but also the mutual connection of the vital and physical forces, and demonstrated before thousands of medical students and physicians "that the same causes and actions which in inorganic bodies constitute physics, in organic bodies constitute physiology, or, as it may be more aptly termed, organic physics."

Mr. Grove,[2] in a Lecture delivered at the London Institution, on the 19th of January, 1842, showed that "light, heat, electricity, magnetism, motion, and chemical affinity, are all convertible material affections; assuming any one as a cause, one of the others will be the effect. Thus, heat may be said to produce electricity, electricity to produce heat; magnetism to produce electricity, electricity magnetism; and so of the rest."

In this same year, J. R. Mayer,[3] of Heilbronn, saw truly and expressed correctly this general law; and in 1843, Colding presented a memoir to the Academy of Copenhagen, in which the same law found utterance.

Dr. H. Helmholtz[4] read before the Society of Berlin, July, 1847,

[1] In the year 1849, in a paper read at the meeting of the American Medical Association, held in Boston, Dr. Jackson announced the correlation of animal mechanic force and heat.

For a condensed statement of the views of this philosopher, see his valuable "Introductory Essay on the Human Organism and its Forces, with Remarks on Dr. Lehmann's Doctrine of Vital Forces," by Samuel Jackson, M. D., Professor of the Institutes of Medicine in the University of Pennsylvania.—*Lehmann's Manual of Chemical Physiology*, translated by J. Cheston Morris. Philadelphia, 1856.

[2] The Correlation of Physical Forces, by W. R. Grove, first ed., 1846; third ed., 1855, London.

[3] Organic Movements in their Relations to Material Changes, 1845. See also Trastour's pamphlet—Caloric, Origin, Matter, and Law of the Universe, 1847. "Identities of Light and Heat, of Caloric and Electricity," by Dr. C. C. Cooper, 1857, British and Foreign Medical Review, article 18, Oct., 1844. Carpenter's Principles of General and Comparative Physiology, 1841, p. 167. "On the Mutual Relations of the Vital and Physical Forces," by William B. Carpenter, M. D., Phil. Trans., June 20, 1850, part ii. p. 727.

[4] "On the Conservation of Force, a Physical Memoir," by Dr. H. Helmholtz (read before the Physical Society of Berlin, July 23, 1847, Berlin, by Reimer), see trans.

a most profound, elaborate, and philosophic memoir on the "Conservation of Force," based upon two maxims:—

1. "That it is not possible, by any conditions whatever of natural bodies, to derive an unlimited amount of mechanical force.

2. "All actions in nature can be ultimately referred to alternate attractive or repulsive forces, the intensity of which depends solely upon the distances between the points by which the forces are exerted."

In this valuable memoir, Dr. Helmholtz refers natural phenomena back to unchangeable attractive and repulsive forces, whose intensity depends solely upon the distance; and establishes, by copious illustrations and mathematical demonstrations, the interaction and indestructibility of the forces of nature.[1]

Organized animated bodies are composed of inorganic elements, and are governed by all the laws and phenomena of inorganic bodies, and are absolutely dependent[2] for their existence upon

in Taylor's Scientific Memoirs, vol. vi. pp. 114—162. "On the Interaction of Natural Forces," by H. Helmholtz, Professor in the University of Bonn, translated by John Tyndall, Phil. Mag., fourth series, vol. ii. p. 487. See also the American Journal of Science and Art, vol. xxiv., September, 1857, pp. 189—216.

[1] See also "Observations and Experiments on the Theory of the Identity of the Agents which produce Light and Radiant Heat," by M. Melloni, Annales de Chimie et de Physique, vol. i. p. 418. Taylor's Scientific Memoirs, vol. i. p. 388. "On the Chemical Effects of Electric Currents of Low Degree in Crystallization," by M. Becquerel, Becquerel's Traité de Electricité et du Magnetisme, vol. iii. p. 287. "On the Application of Electro-Magnetism to the Movement of Machines," by M. H. Jacobi, Potsdam, 1835, Taylor's Scientific Memoirs, vol. i. p. 503; vol. ii. p. 1. "Experiments of Joule determining the Relations of Heat and Electricity," Phil. Mag., vol. xix. p. 275; to Chemical Affinity, vol. xx. p. 111; vol. xxiii. p. 441. "The Galvanic Circuit Investigated Mathematically," by Dr. G. S. Ohm, Taylor's Scientific Memoirs, vol. ii. p. 401. "General Propositions relating to Attractive and Repulsive Forces acting in Inverse Ratio of the Square of the Distance," by C. F. Gauss, trans. in Taylor's Scientific Memoirs, vol. iii. p. 153. "On the Relation of Magnetism to Diamagnetism," by M. Plücker, Poggen. Ann., Oct., 1847; trans. in Taylor's Scientific Memoirs, vol. v. p. 376. "On the Measurement of Electro-Dynamic Forces," by W. Weber, Poggen. Ann., January, 1848; Taylor's Scientific Memoirs, vol. v. p. 489. "On the Mechanical Equivalent of an Electric Discharge, and the Heating of the Conducting Wire which accompanies it," by R. Clausius, Pogg. Ann., 1852; Taylor's Scientific Memoirs, vol. vi. p. 1. "On the Work performed and the Heat generated in a Conductor by a Stationary Current," by R. Clausius, Pog. An., vol. lxxxvii. p. 415; Taylor's Scientific Memoirs, vol. vi. p. 200. Philosophy of the Mechanics of Nature, by Z. Allen, New York, 1852.

[2] Inorganic bodies are wholly independent of the organic, are less complex in structure, their phenomena are more simple, and the laws of their existence more universal. Thus, the bodies oxygen and carbon are widely diffused throughout nature, and their existence is wholly independent of that of any other bodies.

inorganic bodies; they have, however, a new set of phenomena, dependent upon the vital force; and in animals we have another set of phenomena, dependent upon the existence of the nervous system and intellectual faculties; and in man we have another set of phenomena, dependent upon the combination of the intellectual and moral faculties.

Inorganic bodies, with their properties, form the necessary conditions for the existence of plants and animals, just as the properties of cohesion and gravitation form the essential conditions for the existence of the universe, in its present arrangement; the phenomena of living beings, plants and animals, are, therefore, more complicated and less general than those of inorganic inanimate bodies; and it is evident that to understand the phenomena of living beings, and their relations with the universe, we must comprehend the phenomena and relations of all inorganic bodies.

The relative proportions of the inorganic elements entering into the constitution of plants and animals, correspond, in a measure, to the relative quantities of these elements in the exterior world. Whilst the majority of the sixty-two simple bodies, with their compounds, exist only in small quantities, and enter into but few combinations, and exert but little influence upon the phenomena of organized bodies, the elements composing the great mass of our globe are the very elements which are essential to the formation of the structures and manifestation of the forces of animated beings.

Water, which covers two-thirds of the surface of our globe, and is distributed throughout the atmosphere and soil, exists in similar proportions in the structures of plants and animals. We have seen that water is the great medium of chemical change in the inorganic world—that under the action of heat and gravitation, a great circulation of water is carried on through the atmosphere, and over the surface of the continents and islands, which disintegrates and wears down the solid rocks, dissolves and washes away the impurities of the atmosphere and land. An analogous lesser circulation of water, whose existence depends upon the great circulation in the inorganic world, is carried on unceasingly through the textures of plants and animals; and water in the organized world, as in the inorganic, is the great medium of change, and the

Plants and animals are composed in large measure of these two bodies, in combination with hydrogen and nitrogen. Without these elements, with their peculiar properties and arrangements, plants and animals could not exist.

great agent in the removal of disintegrated, chemically altered, offending substances. The amount of water required annually for the circulation through the textures, the distribution of the nutritive materials, and the removal of the waste, useless products of the billion inhabitants of the earth, is, at the lowest calculation, 1,500 billion pounds; while 3,000 billion pounds are required for the accomplishment of similar offices in the animal kingdom; and the vegetable kingdom, at the lowest calculation, requires annually 9,288,000,000,000,000 pounds, or 4,644 billion tons of water.

Eight-ninths of all the water, one-fifth of the great ocean of gaseous matter, and from one-half to two-thirds of the solid crust of our globe, are composed of oxygen, in combination with hydrogen, silicum, aluminum, calcium, sodium, potassium, magnesium, iron, and carbon. In the inorganic world oxygen is the great purifier of earth, air, and sea—the great element of combustion—the great element of chemical change—which, excited by the forces of the sun, works unceasingly. Oxygen constitutes from two-thirds to four-fifths of the structures of plants and animals, and immense quantities are used in the chemical changes of the elements during the construction and disintegration of the tissues and the development of the forces; the human race alone annually consumes 800 billion pounds of oxygen, in addition to the 1,322 billion pounds contained in the water circulating annually through the textures. The oxygen enters into combination with the elements of the food, and of the tissues and organs—during these ceaseless chemical changes the integrity of the structures and the individuality of animals are preserved, and the forces which work their machinery generated. The structures of plants and animals are composed chiefly of three gases and one solid; they are dependent, however, upon the soil for certain salts of lime, soda, potassa, silica, and iron. These salts, although existing in small amount, are absolutely necessary for the existence of plants and animals; every soil which does not contain these salts in an available form for plants will not support the higher species necessary for the elaboration from inorganic matter, of compounds necessary for the structures, and chemical changes and development of the forces of the most highly developed animals. The absence of a single inorganic constituent from the food of man and the higher animals, will be attended by derangement of the structures, aberration of the forces, and, finally, death. The researches of chemists, physiologists, and pathologists,

have shown that more than two-thirds of the sixty-two simple elements, with their various compounds, so far from entering into the constitution of plants and animals, are dangerous poisons, capable, in the smallest quantities, of producing death. This comparison of the mineral constituents of plants and animals with the constituents of the crust of our globe, develops such a close correspondence that the conviction is forced upon us, that not one of the essential constituents of the crust of our globe could be altered, either in quantity, distribution, or chemical relations, without the destruction of animals and vegetables. What would have been the result if arsenic had been as widely distributed as iron? What would have been the result if the chlorine of the sea-water and crust of our globe had been united with mercury instead of with sodium? Nor is this all; the very scarcity and poisonous properties of these substances have exerted great influences upon the development of certain arts and sciences.

Whilst inorganic bodies form the structures of plants and animals and retain all their physical and chemical properties and relations, whilst the circulation of matter in the organized world is carried on by the same forces as in the exterior inorganic world, and whilst there is no creation of matter or of force in the bodies of animated beings, it is, nevertheless, true that living beings have a new set of phenomena, and that their structures and phenomena are more complicated and less general than those of inorganic bodies.

Without entering into an enumeration of all the distinctions between inorganic bodies and animated beings, it may be stated that inorganic bodies are homogeneous in structure, and would remain forever at rest and unchanged, physically and chemically, unless acted upon by extraneous forces, and in inorganic compounds the biniary arrangement is pursued; whilst, on the other hand, all vegetables, from the simple cell to the most highly developed, and all animals, from the simple cell animalcule to the complicated organism of man, have arisen from cells, and are composed of cells variously developed and grouped, so as to form organs, and systems of organs, and apparatus, capable of accomplishing definite results, when moved by the proper chemical and physical forces, and in organic compounds, four bodies, carbon, hydrogen, oxygen, and nitrogen, unite in varying proportions, forming an endless series of compounds.

Amidst the unceasing chemical and physical changes of the materials of organized beings, individuality of form is preserved and

unity of action maintained. The development of a definite form from a formless mass, and the preservation of that form amidst unceasing chemical and physical changes, is the great characteristic of organized beings.

As no force or combination of forces in the inorganic world can accomplish the development of a form from a formless mass, and the preservation of that form amidst unceasing chemical changes, the human mind, reasoning upon the axiom that every effect must have a cause, refers these effects to a special cause, called the vital force. It is true that no one has ever seen this force. We know it only by its effects. The same thing is true of all forces. No one has ever seen the force (the cause of the phenomena) of heat, light, electricity, or magnetism. We do not observe forces, but we infer their existence from their effects. The conclusion, then, that animals and plants are endowed with a force which inorganic bodies do not possess is logical. We can come to no other conclusion if we reason in accordance with the structure of our minds. If it be true that the human mind is the work, and even the reflection of the image of the Creator, who is himself Truth, we are confident that whenever our minds reason in rigid accordance with all the known facts, and their own structure, they must obtain the truth.

In this view of the relations of organized and inorganic bodies, we do not attribute to the vital force any power to produce either chemical, or physical, or nervous forces. Its power is limited to a direction of the forces of matter, so that a form is developed from formless matter, maintained, and definite results accomplished, and unity of action preserved. All the movements in plants and animals depend ultimately upon the chemical changes and physical properties of their elements, and upon the forces of the sun. Without these forces the vital principle can accomplish nothing.

According to this view the action of the vital principle, like that of the intelligence, is limited to a guidance and direction of the forces with which the Creator has endowed all matter. The action of the vital principle upon matter, like that of the intelligence, does not consist either in a creation of matter, or in a direct movement of matter independent of the forces of matter, but in the mere guidance and application of the forces of matter, so that definite forms are developed from formless matter, and definite results accomplished.

According to this view the vital principle and the intelligence cannot create force any more than they can create matter. Their

influence is limited to an excitement and application of the forces of matter. We judge of the influence of one just as we judge of the influence of the other. The complicated machine points to the existence of an intelligence distinct from matter, which has so applied the forces of one portion of matter that another portion has been moulded into definite shapes, and formed into definite apparatuses, capable of accomplishing definite results, when acted upon by forces generated and applied in the right manner. We infer the existence of the intellect by the results of its application of the forces of matter. In precisely the same manner do we infer the existence of the vital principle.

The vital principle directs the forces resulting from the chemical changes of one part of matter, in such manner that surrounding matter is fashioned, moulded into definite forms and apparatuses, destined to accomplish definite results. This apparatus cannot be worked by the vital principle independent of chemical action, any more than a watch will run or any machine accomplish various mechanical effects without a supply of exterior force, or a steam-engine accomplish mechanical effects without the development of force by the chemical changes of matter, which has been elevated into a state of force (placed in a state capable of undergoing chemical change) by the forces of the sun.

In the living animals the forces resulting from the chemical changes are expended under the direction of the vital principle to accomplish:—

1. The preparation and elevation of new materials into the place of that which has been chemically altered during the development of the forces.

2. The removal of the products of the chemical changes, which are no longer fit to form the organized structures, and are no longer capable of undergoing the changes necessary for the development of the forces.

3. The working of the apparatus which distributes the elements of secretion, and excretion, and force, expels the excretions and moves the body.

In the living animal the rapidity of the chemical changes which develop the forces of the machinery, depend, first, upon the supply and distribution of materials capable of entering into the constitution of the organs, tissues, and apparatus; secondly, upon the supply and distribution of materials capable of undergoing chemical change within and around the machinery, and thus generate the

forces in positions advantageous for their application; thirdly, upon the replacement of the chemically altered matter which once formed part of the apparatus (machinery) by new matter; fourthly, upon the removal of the products of chemical change, which derange chemical action—first, by occupying positions in the apparatus which should be occupied by matter in a state of force, and not by matter which has lost the amount of force originally received from the sun; secondly, by inducing chemical changes in wrong positions in parts of the organism where the forces resulting from their chemical changes cannot be applied; and, thirdly, by a direct poisonous effect upon the organs, tissues, and apparatus, especially upon the nervous system, which keeps up a communication between all parts of the system, and controls, in a great measure, the distribution of the elements of nutrition and chemical change, by controlling the action of the respiratory and circulatory apparatus. The supply and distribution of the materials of nutrition and che mical change depend, first, upon the perfection and action of the vegetable kingdom, and, secondly, upon the perfection and action of the animal, digestive, circulatory, and respiratory apparatus, related and co-ordinated by the nervous system.

The study of the animal kingdom as a whole demonstrates that the perfection and action of the respiratory and circulatory systems may be taken as an index of not only the physical and chemical changes of the organized fluids and solids, but also of the development and perfection of the organs, and tissues, and apparatus, and of the activity and intelligence of animals.

The action of the respiratory and circulatory apparatus, the coordination of this action with the action and wants of the muscular and nervous systems, and of all the organs, and tissues, and apparatus, is guided by the nervous system, in which a special force is generated—excited and guided by nervous force, but not carried on by nervous force, independent of chemical change.

Chemical change in the organs and apparatus, and chemical change in the nervous systems, is the source not only of heat, but of muscular and nervous force, and of all the forces generated in the animal economy.

All the acts called vital, and nervous, and muscular, by many physiologists, such as the contraction of the muscles, and the transmission of impressions to and from the nervous sensitive centres along the nerves, are due to the chemical changes of those elements which have been separated from oxygen, and elevated into

a state of force (capable of chemical change) by the forces of the sun, acting through special organs in the vegetable kingdom. There is a change of force in direction and mode of action, but there is no creation of force.

The generation of any force—vital, nervous, chemical, or physical, in the animal economy, independent of antecedent force, would destroy the great law upon which the stability of the universe rests, that force is indestructible—would destroy the great law that action and reaction are equal.

The vital force does not create any force, however feeble; but, like the intellect, merely employs the forces with which the Creator has endowed matter, just as a master-workman employs the forces of men to act upon matter and construct an edifice. If the vital force be not analogous to intelligence, how does it come that all the organs and apparatus are developed upon a definite plan, adapted by structure and conformation to the medium in which the animal lives, and to all the physical forces?

The difference between vegetables and animals, and between the different species of each kingdom, depends not upon differences of forces, or of the elements of their structures, but upon the difference of the development of the apparatus by which the physical and chemical forces are applied. Thus, vegetables are fixed to the soil, and their structures are all arranged, for the accomplishment of a definite purpose—the application of the forces of the sun to the grouping of the atoms of inorganic matter, and the products of the disintegration of the tissues of animals, in such a manner that they may not only form the tissues and organs of plants and animals, but also that they may be capable of undergoing change, and of giving back the same amount of force which they had received from the sun.

The arrangement of the atoms of the structures of animals, and the forces resulting from the chemical changes of these atoms, are resultants of the forces of the sun, acting through special organs of plants, and guided by the vital force of plants, so as to overcome the chemical affinities of certain elements, separate them, place them in a situation where they can again undergo chemical change, and give out the force originally expended by the sun in overcoming their chemical affinities.

All matter upon the face of our globe tends continually to come to rest. This tendency is due to several causes, as the action of gravity, the limited amount of force with which matter is endowed,

and the continued radiation of heat into space, and the loss of the forces of the elements by radiation during their chemical union. Without a continued supply of force all motion would cease, both in the inorganic and organic worlds.

The great force which moves the crude sap of plants from the roots to the leaves, from cell to cell, in opposition to the force of gravity, is endosmose, which is itself dependent upon chemical actions, and the varying densities of the contents of the cells, both of which depend ultimately upon the forces of the sun. After the inorganic elements and moisture have been supplied, the luxuri ance and perfection of plants depend upon the intensity of the forces of the sun.

The truth of this proposition may be established by a reference to the distribution of plants upon the surface of our globe, and upon mountains, which rise to a great height in tropical countries.

Whilst in equinoctial and tropical countries, where a sufficient supply of moisture combines with the influence of heat and light, vegetation appears in all its magnitude and glory; on the other hand, in polar regions, and upon the summits of lofty mountains, all the more complicated forms of vegetable existence disappear, and lichens and microscopic plants take the place of the majestic forests and impenetrable jungle. In the tropics the lowest orders of plants are comparatively rare; whilst in the polar regions, and upon the summits of mountains, they form almost the entire vegetation.

The strength and activity of animals depend upon the development of the apparatus by which the elements for chemical change are distributed, and the forces resulting from these chemical changes applied, and a free communication between the different systems of organs kept up. The development of the apparatus depends upon the directive influence of the vital force.

The truth of these propositions may be clearly demonstrated by a comparison of the phenomena and anatomical structures of the different species, genera, orders, and classes of animals. Thus, the sluggish, feeble, cold-blooded animal is such, not from any peculiarity of the elements or forces of its structures, but from the imperfect development of the structures and apparatus by which the elements of chemical change are distributed, and the forces resulting from these changes applied. The forces of an animal with imperfectly developed lungs and circulatory apparatus are necessarily feeble, because the apparatus for the introduction and

distribution of the great agent of chemical change (oxygen) are defective in their action.

In the animal, as in the plant, and as in the universe, there is no creation of force independent of the Creator. The geographical distribution of plants, and the relations of animals to the forces of the sun (surrounding temperature), demonstrate conclusively this proposition. The independence of higher animals of surrounding cold (absence of heat or force) is due solely to the fact that they can receive and distribute rapidly the materials necessary for the development of the physical, chemical, and nervous forces. As the external temperature diminishes, the internal chemical changes correspondingly increase. If, however, the external heat diminishes to a point at which the heat lost by radiation from the surface of the body of the living being is greater than that developed by the greatest possible combustion, the warm-blooded animal will be reduced to the condition of a sluggish cold-blooded animal, and finally lose all motion and life. The distinction, then, between cold and warm-blooded animals, drawn from their temperature and corresponding forces, is relative and not absolute.

As far, then, as the knowledge of man extends, the great law of the indestructibility of force, and the great law that action and reaction are equal, are applicable to all phenomena, inorganic and organic.

Physical and chemical forces exist independently of the vital force; the vital force, on the contrary, cannot exist and manifest its peculiar effects without matter and the physical and chemical forces; the acts of development, nutrition, secretion, and excretion, and propagation, which are peculiar to plants and animals, are resultants of the action of the physical and chemical forces upon matter, under the guidance of the vital force, which is incorporated with and presides over every molecule of living organized matter, and directs all its physical and chemical changes, so that amidst innumerable and unceasing changes the individuality of every organ, apparatus, and animal is preserved.

As the germination and development of vegetables and animals, and the maintenance of their life actions, depend essentially upon the properties of matter, upon the relations of matter to the sun and fixed stars, and upon the correlation of the vital, chemical, and physical forces, it is evident that the study of complicated, highly developed plants and animals involves the consideration of their origin, development, structure, and relations to exterior bodies—involves the consideration of the chemical and physical properties of the elements, and combination of elements

entering into their constitution, and the relations of the constituents of their bodies to the surrounding medium—involves the consideration of the relations of the vital, chemical, and physical forces, and intellectual and moral faculties—involves the consideration of the relations of animated beings to the forces and arrangements of the sun, and planets, and fixed stars.

The history of the origin, development, and distribution of plants and animals, as revealed by the records upon the solid rocks; the geographical distribution of the plants upon the surface of our globe at the present time; the geographical distribution of animals, and the relations of animated existence to the surrounding medium and external forces as revealed in the correspondence of the internal structures and forces with the arrangements and chemical relations of the elements and the rapidity of the chemical changes, demonstrate that the most simply constructed plants and animals are more widely distributed over the surface of our globe, and the conditions of their existence more general and less complicated than the more highly developed plants and animals; demonstrate that as we rise in the scale of animal and vegetable existence, the phenomena of life become more complex and less general, and the conditions of their existence more complicated and restricted.[1]

[1] The truth of these propositions may be illustrated in a forcible manner by the relation of vegetable and animal existence to the distribution of the forces of the sun upon the surface of our globe. Thus, as a general rule, after the inorganic elements and moisture have been supplied, the luxuriance and perfection of plants depend upon the intensity of the forces of the sun. The more complicated and perfect the vegetable structures, the closer is their dependence upon the proper supply and balance of the physical forces. The converse of this proposition is also true. The truth of these propositions may be established by references to the distribution of plants upon the surface of our globe, and upon mountains which rise to a great height in tropical countries. Whilst, in equinoctial countries, where a sufficient supply of moisture combines with the influence of heat and light, vegetation appears in all its magnitude and glory; on the other hand, in polar regions, and upon the summits of lofty mountains, all the more complicated forms of vegetable existence disappear, and lichens and microscopic plants take the place of majestic forests and impenetrable jungles. In the tropics the lowest orders of plants are comparatively rare, whilst in polar regions and upon the summits of mountains they form almost the entire vegetation. The plants which first form upon barren rocks, and lava streams, and coral islands, are those of the most simple organization. The simply organized lichens covering the bald-granite rocks are familiar to every resident of a primitive region. Along the sides of Etna, Ischia, Vesuvius, and other volcanoes, lava streams are seen stretching in all directions, which have flowed down like rivers. These lava streams are of different ages, and many of them were formed within the memory of man. An investigation

An examination of the origin, development, structure, and relations of all vegetables and animals, commencing with the

of these lava streams affords an opportunity of determining the gradual distribution of vegetables. Some are still naked, others have only a few plants scattered here and there in hollows and crevices, and in others the decaying plants are forming a soil. According to the observations of Prof. J. F. Schow, the plants which first settle upon the naked lava, and form a soil for the more complex, are especially those lower and simply organized plants, called lichens. Certain sncculent and fleshy plants, as the Indian fig (*opuntia vulgaris*), which are nourished chiefly by the carbonic acid and aqueous vapor of the open air, absorbed by the stem and leaves, are also amongst the earliest inhabitants of the lava streams. Geology also teaches that the lower orders of plants appeared first upon our globe.

As the luxnriance and perfection of plants depend upon the temperature of the surrounding medium, and the intensity of the forces of the sun; so also the perfection of the nervous system, and of all the organs and apparatus, and the activity and intelligence of animals, correspond, in a great measure, to the rapidity of the physical and chemical changes going on in the molecnles of their bodies, and to the relations of the physical, and chemical, and vital forces, and to the temperatnre which they are able to maintain, regardless of that of the snrronnding medium.

As the chemical changes become feeble, and the temperature of animals descends and becomes dependent upon that of the snrronnding medium, they become more simple in their organization and mode of life, the conditions of their existence become less restricted, and they resemble closely the simple forms of vegetables, and in the twilight of existence we can scarcely distinguish between the lowest forms of plants and animals.

If we examine the relations of the physical and chemical agents to the animal kingdom, we will find that the most simply constructed animals, many of which are devoid of a nervous system and special organs of sense, as the infusoria, are, as in the case of the simply organized plants, the most widely distributed over the face of our globe, and are at the same time far less dependent for their existence upon the temperature of the surrounding medium.

Infusoria occnr in immense numbers in every sitnation: in stagnant pools, in marshes, in mud of rivers, in peat earth, twenty feet below the surface; in the strnctures and fluids of living animals and vegetables, in putrefying organic matter, in the bed and waters of the ocean, in snow, in ice, and in boiling springs.

Sir John Ross, in the year 1840, picked up some brash ice of a brown yellow color in the Arctic regions, not far from Mount Erebus, which was supposed to contain aluminous matter, ejected in fine ashes from the volcano. Specimens were brought home in sealed glass vessels, and forwarded to M. Ehrenberg.

This microscopist fonnd the coloring matter to consist of myriads of infusoria, almost the whole of which reached Berlin in 1844, in a living state. Here we see that these microscopical animals, after having been frozen and thawed out, lived without food for four years. Certain species of these animalcules have been found living and propagating in boiling springs, and some of them have been observed to recover after drying in vacuo along with chloride of calcium and sulphuric acid for twenty-eight days, and after exposure to a heat of 248°. The infusorial animals were created at an early geologic period, and a large number of the fossil species, which compose the polirschifer and semi-opal of Bilin, are found at the present time living and propagating in the seas and oceans. The infusoria form a chain

simplest, and ending with the most complicated, leads us to the summit of the pyramid upon which stands man—governed by all the astronomical and chemical and physical laws of inorganic bodies, and comprehending within himself all organic nature—arising in common with plants and animals, from the organic cell, and like them, passing through various stages of development—endowed in common with all vegetables and animals, with vital force—possessing in common with all animals, and in contradistinction to vegetables, a nervous system endowed with special sensibilities, relating the intellectual faculties to the exterior world, and relating the various organs and apparatus to each other, in such a manner that, amidst an innumerable number of complex actions, unity and harmony result—an organism composed of inorganic elements, prepared and grouped into definite compounds

connecting the organic life of distant ages of the earth, and demonstrating conclusively that the distribution of animals, and the power to survive physical changes, depends upon their development.

The simpler the structures, the feebler the vital, nervous, and physical forces, the less complicated the conditions of existence. The gelatinous medusæ (gelly fishes) occur in such vast numbers in the cold Greenland sea, that they impart an olive green color to the sea, rendering the water dark and opaque, in comparison with the ordinary cerulean hue. Cold-blooded vertebrate animals, although more highly organized than invertebrate animals, still show remarkable powers of enduring extremes of heat and cold without death. Fish may be frozen and again thawed out without a destruction of life. The rapidity with which the absence of heat is attended with loss of sensibility and death, is directly proportional to the development and perfection of vertebrate animals.

The relations between the physical, chemical, and vital forces are strikingly exhibited in certain cold and warm-blooded animals, which become torpid or hybernate during the winter season. In this state all the chemical and physical actions are of the most sluggish character. The heart scarcely beats, the frequency and force of the action of the heart and flow of the circulation is greatly diminished if not entirely stopped. The amount of carbonic acid thrown off from the lungs is greatly diminished, and all the chemical and physical changes of the elements of the tissues, and fluids, and organs of these animals are retarded. If the temperature of a warm-blooded animal be reduced, in like manner all its physical, chemical, and vital actions will be depressed, and the active animal will be reduced to the condition of a sluggish cold-blooded animal, and death will rapidly ensue. There is, however, this great difference between the cold and warm-blooded animal—the conditions of the existence of the latter are far more restricted than those of the former. The chemical changes of the cold-blooded animal are slow, and it can exist without food for weeks and months, whilst a few days' starvation is fatal to the warm-blooded animal. These facts demonstrate conclusively that the conditions and phenomena of life are complicated and restricted, in exact accordance with the development and perfection of the organs and tissues of animals, and the rapidity of the chemical and physical changes of the molecules of their bodies.

in the vegetable kingdom, by the combined actions of the vital principle, and the physical and chemical forces of matter and the sun; perfect in its mechanical structure, and in the arrangement of its parts, with the size of its organs, the strength of its muscles and bones, and the vigor of its forces, constructed and arranged with exact reference to the force of gravity, the size of our globe, and its relations with the sun, and all other worlds in the universe—worked by forces, always the resultants of the chemical changes of those substances which, in the vegetable kingdom, have been elevated into a state of force, by the action of the sun upon matter in the vegetable laboratory—worked by forces to which the great laws of mechanics apply—possessing intellectual faculties, capable of receiving impressions from the motions of exterior bodies, and of exciting the forces by which they are surrounded, and directing them so as to act upon exterior matter, and overcome all the barriers and obstacles of nature, not by a suspension or alteration of her laws, but by peculiar applications of those forces and laws—endowed with moral faculties which distinguish him from every other form of matter, and every other being upon our globe—revolving with the earth and planets around the sun, and with the whole system, moving through the great ocean of space, around a distant unknown centre—with an existence like that of plants and animals dependent upon the length of the day and of the year, and of the seasons, which are dependent upon the adjustments of the solar system; dependent upon the constitution of terrestrial bodies, and their relations with celestial bodies.

Man, then, is a type of the universe.

If a single one of the nice adjustments and relations of the component members of the solar system were materially altered, or even if the relations of the solar system with the exterior universe were materially altered, derangement of the structures, and final destruction of the human race must follow.

To understand the phenomena of man in health and in disease, and his relations to the universe, we must comprehend the phenomena and mutual relations of all animate and inanimate bodies, terrestrial and celestial.

CHAPTER II.

THE EXTENT, OBJECTS, AND IMPERFECTIONS OF PATHOLOGICAL INVESTIGATIONS.

In the preceding chapter we endeavored to sketch the general relations of man to the exterior universe, and demonstrate the extent and complexity of his phenomena.

If man be related to celestial and terrestrial bodies—if the existence of man be dependent upon the adjustments of the solar system, the seasons, the climate, the action of the vegetable kingdom, the soil, and upon the great circulation of matter, kept up by the forces of the sun—if the derangement of only one link in this complicated chain of phenomena would result in the destruction of the human race—if the phenomena of man in health be thus complicated, how much more complicated must be the phenomena of disease, when the constitution of the complex solids and fluids of man may be altered in many ways, and the relations between the physical, chemical, vital, and nervous forces, and intellectual and moral faculties may be correspondingly deranged.

In view of the immensity and complexity of physiological and pathological phenomena; in view of the fact, that no single man, even during a long lifetime, is capable of investigating thoroughly the phenomena presented by only one disease, the investigator should always state clearly his views of the extent and bearing of physiological and pathological phenomena, and define the scope and bounds, and methods of his investigations, and candidly acknowledge their omissions and imperfections.

We will now proceed, in a condensed and brief manner, to point out the sources of disease.

1. Astronomical changes are attended by corresponding changes in the phenomena of man. The changes of the day, and month, and year, and seasons are attended by corresponding changes in the constitution and phenomena of man. Not only would derangement of the adjustments of the solar system be attended by corresponding derangements in the little world of man, but his diseases,

arising from whatever cause or causes, must be influenced by these changes. As the sun with his attendant planets are progressing continuously through space, it is not unreasonable to suppose that the phenomena of man might be modified by the properties and forces of the regions of space through which the solar system travels. That a resisting medium does exist in space, to which the transmission of luminous and thermic vibrations may be referred, has been conclusively demonstrated by astronomers in the case of Encke's comet. What the matter is composing this resisting medium, and whether this matter is uniform, or varies with the different regions of space, and whether it exerts any influence upon the phenomena of man, are questions worthy of a solution.

Geology teaches that the climate of this earth has been altered during different periods of past times, and that causes have in past times destroyed whole races of plants and animals. Whether these causes were astronomical or terrestrial, it is nevertheless true that similar causes may be the sources of disease.

2. The surrounding medium may be physically and chemically altered, either by an excess or deficiency of its ordinary ingredients, or by an excess or deficiency of the forces by which it is circulated.

Whilst it is true that the amount of force annually received by the earth from the sun is a fixed quantity, it is nevertheless true that, owing to the peculiar constitution of the atmosphere, the nice adjustment of its forces (the ease with which one mode of force may be converted into another, as heat into electricity, and *vice versa*), its relations to moisture, its relation to the distribution of the forces of the sun, and its relations to the distribution of the solid and fluid masses of the earth; the climate is subject to variations which cannot be predicted, and are not uniform. Corresponding disturbances are produced in the phenomena of man. The truth of this proposition is conclusively demonstrated by the relations of certain diseases, as pleurisy and pneumonia, to the weather. And even when diseases are not directly produced by the disturbances of the structure and forces of the surrounding medium, it is nevertheless true that the course and phenomena of disease are modified, to a great extent, by meteorological phenomena. The value of the determination of these relations in the investigation of the origin, progress and treatment of disease, cannot be over-estimated.

3. As the compounds composing the body of man have all been formed by the vegetable kingdom, from the inorganic elements, it

follows that any deficiency of the necessary elements of the soil would be attended by deficiencies in the constitution and by composition of the food, elaborated by the vegetable kingdom, and by corresponding disturbances of the constitution and phenomena of man. Corresponding changes in the constitution and phenomena of plants may be induced by meteorological phenomena. Hence, in the investigation of the origin and phenomena of disease, it is necessary to determine the chemical and physical constitution of the soil, and its relations to the vegetable kingdom.

4. The salts of the blood, which are absolutely necessary for its healthy constitution, are obtained in part from the water daily introduced into the system. These salts may exist in deficiency or excess; and other abnormal noxious, saline and organic matters may exist in the water. Each of these causes may be a source of disease. Hence the necessity in pathological investigations of a careful examination of the water.

5. Any one of the normal constituents of the body of man may be deranged, and occupy different relations to each one of the other constituents. As these constituents are numerous, the resulting derangements may be correspondingly numerous. The forms of this class of diseases may be as numerous as the different positions which the elements may be made to assume towards each other.

6. Any one of the elements of his body may be in excess or deficiency, and the diseases may be as numerous as the elements themselves, and at the same time, totally different from the diseases arising from an alteration in the relative position of the elements.

7. Foreign morbific agents may be introduced into the fluids and solids, which will excite abnormal changes in the solids and fluids. The generation of these morbific agents will depend, in great measure, upon the relations of climate and soil, and water and organic matter, and the forces of the sun. The number of diseases of this class will correspond to the number of distinct morbific agents.

Combinations of these morbific agents may produce still more numerous and complicated diseases.

8. As the matter composing the human body is fashioned into definite organs and tissues destined to accomplish definite results, and combined into apparatuses, definitely related to each other, it is evident that the disturbance of the mutual relations of any one of these organs and tissues and apparatus must, to a greater or

lesser extent, produce corresponding disturbances in the component members of the human organism.

9. The Creator has associated the vital force with a definite constitution of matter. Whatever interferes with this constitution, interferes with the action of the vital force. Whatever interferes with the vital force, necessarily disturbs its relations with the physical, chemical, and nervous forces. If the balance of the forces, their correlation be disturbed, the chemical actions between the elements may not only be deranged in kind, but also in degree, and the generation of the physical forces which work the machinery, and the manifestation of the nervous, intellectual and moral phenomena, correspondingly altered.

10. The development and structure of the vegetable kingdom—the development and structure and actions of the most simply constructed animals—the appearance of the nervous system in the animal kingdom, and in the fœtus of the higher animals, subsequently to the grouping of the atoms of formless matter into definite forms and apparatuses—the formation of the digestive and circulatory apparatus, before the formation of nervous cells and nervous systems, demonstrate unequivocally, conclusively, and absolutely, that development, nutrition, and the direction of the forces of matter to the fashioning of another part are under the guidance of the vital principle—demonstrate unequivocally, conclusively and absolutely, that the nervous system is itself developed and its perfection maintained under the guidance of the vital principle. Hence diseases may arise independently of the nervous system. Hence we may have chemical and physical changes of the elements of all the organs and systems of organs, incompatible with the existence of the vital force in that altered matter.

Whilst we admit these propositions, we must at the same time bear in mind the true offices of the nervous system. The nervous system is the last and best work of the forces of matter directed by the vital force, and is destined to form the medium of communication between the intellectual faculties and the exterior world; and is destined to connect together and influence the various organs and apparatuses; and is destined to regulate secretion and excretion, and the consequent development of force; and is destined to excite and control the actions of the dynamic muscular apparatus, not by the possession and emission of a peculiar force generated *de novo*, but rather by a modification of physical force generated by the mutual chemical reactions of the blood and nervous systems.

That the nervous force is not capable of itself of carrying on the acts of nutrition, secretion and excretion, is conclusively demonstrated by the fact that plants, and the simply constructed animals, which are devoid of a nervous system, are capable of carrying on the offices of generation, development, digestion, assimilation, nutrition, secretion, excretion, and of preserving a definite form amidst unceasing chemical changes. Many of the simply organized animals, although without a nervous system, still possess sensation and voluntary motion. The nervous system appears only when the parts of the machinery are complicated, and need special means of communication.

The development and perfection of the nervous system correspond exactly to the development, perfection and complication of the organs and apparatus. This fact is true of the animal kingdom, in its successive degrees of development, and also of the successive stages of the development of the solids and fluids of each individual highly organized animal. Physical and chemical actions take place in a similar manner in all animals, simple or complex; they differ only in intensity. The higher the animal, the more complicated its parts, the more rapid the chemical changes, and consequent generation of the forces, and the greater is the necessity for some special apparatus which will bring all the complex organs and apparatus and actions into harmonious relation.

Unless the actions of different organs can be telegraphed (so to speak) to each other, confusion in a complicated organism will necessarily result. Thus, if the amount of blood circulating through any organ and the chemical actions are too great, how can they be regulated without some medium of communication, and some means of regulating the chemical and physical actions.

The observations and experiments of Rufus Ephesus,[1] Galen,[2] Piccolhomini,[3] Riolan,[4] Plempius,[5] Wills,[6] Chirac, Winslow, Bohn,[7] Duverney, Vieussens,[8] Schrader, Valsalva, Morgagni, Baglivi, Con-

[1] Appellationes, Part. Hum. Corp. Græcé. Parisiis, 1554, p. 32.

[2] Galeni Opera. Venetiis, apud Juntas, 1576, de Hippocr. et Plat. decretus, lib. ii. cap. vi. p. 238.

[3] Anatomicæ Prælectiones Archang. Piccolhomini, Romæ, 1586.

[4] Opera Anatomica. Lutetiæ Parisiorum, 1649.

[5] Fundamenta Medicinæ. Lovanii, 1644.

[6] Opera Omnia, edente Balsio. 1682, tom. i. Nervorum Descriptio.

[7] Circulus Anatom. Physiol. Lipsiæ, 1697.

[8] Treatise on the Heart, Toulouse, 1715.

ter, Berger,[1] Ens Sinac, Huermann, Haller,[2] Brunn,[3] Molinelli, Petit,[4] Fontana,[5] Cruikshank, Haighton, Meyer, Bichat,[6] Dupuytren, Dumas,[7] Bainville, Provincal,[8] Vesalius, Columbus Riolan,[9] Bidloo,[10] Muralto, Chirac, Courten, Drelincourt,[11] Martin,[12] Emmet, Portal, Prochaska,[13] Winslow,[14] Le Gallois,[15] Philip, Lobstein,[16] Reid,[17] Krimer, Arnemann, Longet,[18] Brodie,[19] Chossat,[20] McCartney,[21] Nasse,[22] Bernard,[23] Hall,[24] Brown-Séquard,[25] and others, have demonstrated that to the nervous system is delegated this property of regulating the action of the organs and apparatus, and thus regulating the amount of oxygen and blood supplied to the organs and tissues and apparatus.

The blood supplying the nutritive elements of the tissues and organs, and the materials for the secretions and development of the

[1] Physiologia Medica, Francofurti, 1737.

[2] Mémoires sur les parties sensibles et irritables, tom. i.

[3] Commentarii de rebus in Scient. Nat. et Medic. Lipsiæ, tom. iv.

[4] Mémoires de l'Académie des Sciences, an. 1727.

[5] Traité sur le Venin de la Vipère.

[6] Recherch. Phys. sur la Vie et la Mort, Inséré dans la Biblioth. Médic., tom. xvii. p. 1. Physiological Researches on Life and Death, by Xavier Bichat, trans. by F. Gold, London.

[7] Journal Général de Médecine, par M. Sédillot, tom. xxxiii.

[8] Bulletin des Sciences Médicales.

[9] Encheididium Anatom. Parisiis, 1658. Opera Anatomi.

[10] Exercitationes Anatom. Chirurg. Lugd. Batav., 1708.

[11] Experimenta Anatom. Lugd. Batav., 1681.

[12] Essais et Observ. de Médecine de la Société d'Edimbourg. Paris, 1742.

[13] Opera Minora. Viennæ, 1800, tom. ii.

[14] Exposition Anatom. Traité des Nerfs.

[15] Experiments on the Principle of Life, and Particularly on the Principle of the Motions of the Heart, and the Seat of this Principle, by M. Le Gallois. Translated by N. C. and J. G. Nancrede, Philadelphia, 1813.

[16] Structure, Functions and Diseases of the Human Sympathetic Nerve, by John Fred. Lobstein. Translated by Joseph Pancoast, M. D., Philad., 1831.

[17] "An Experimental Investigation into the Functions of the Eighth Pair of Nerves," by John Reid, M. D. Edinburgh Medical and Surgical Journal, 1838.

[18] Traité de Physiologie, Paris, 1850, t. ii.

[19] Medico-Chirurg. Trans., 1837, vol. xx. p. 132.

[20] Mém. sur l'influence du syst. nerv. sur la chal. anim. Thése de Paris, No. 126, 1820.

[21] Treatise on Inflammation, 1838, p. 13.

[22] Untersuchungen zur Physiol. und Pathol., 1839, vii.

[23] Gaz. Médic. de Paris, vol. vii. No. 14.

[24] Phil. Trans., 1833. On the Diseases and Derangements of the Nervous System, by Marshall Hall, M. D., London, 1841.

[25] Experimental Researches applied to Physiology and Pathology, by E. Brown-Séquard, New York, 1853.

forces, and oxygen being the active agent in all the chemical actions of the bodies, it is evident that whatever disturbs the constitution of the nervous system, necessarily disturbs the functions of the apparatus and organs, and produces corresponding alterations in their secretions and excretions.

As the integrity of the nervous system depends upon the integrity of the blood, in like manner whatever alters the constitution of that fluid will produce aberrated action in the nervous system, and in turn, this disturbance may extend itself indefinitely.

Disease, then, whether arising in the organs, or in the blood, or originally in the nervous system, will always be attended by aberrated nervous action. The most prominent symptoms of disease will be manifested by the nervous system.

The value of the phenomena manifested by the nervous system during febrile diseases, has been recognized by no one more fully than Professor Henry F. Campbell,[1] M. D., in his able and elaborate classification of fever by the nervous phenomena.

In all our investigations into the causes and effects of disease, we should always remember the distinction between the offices and phenomena of the two systems of nerves, the cerebro-spinal and sympathetic.

Long before Haller, the intellectual functions, sensation, and voluntary motions, had been distinguished from those which are exercised without our knowledge, and over which our will has no command, such as circulation, nutrition, and secretion. The former were distinguished under the name of external animal functions, and the latter under the name of internal natural functions, and both orders of functions were known to be equally under the control of the nervous power. Willis[2] asserted the distinction between the nerves destined to voluntary motions and those which preside over the internal natural functions which are independent of the will. He placed the origin of the nerves of the external animal functions in the cerebrum, and that of the nerves of the internal natural functions in the cerebellum, and contended that if the motions of the heart as well as the other vital functions do not

[1] Report on the Nervous System in Febrile Diseases, and the classification of Fevers by the Nervous System, by Henry Fraser Campbell, A. M., M. D., Professor of Anatomy in the Medical College of Georgia, at Augusta. Transactions of the American Medical Association, 1858.

[2] Tho. Willis opera omnia, edente Ger. Balsio. Amstelodami, 1682. Tom. i. de Cerebri Anatome, cap. xv.

undergo any interruption, it is because the action of the cerebellum continues without ceasing; whilst on the contrary the voluntary motions require repose, because the action of the brain is intermittent.

Boerhaave[1] adopted the opinions of Willis, and in the action of the heart, in addition to nervous action, he admits two other causes of its motions, and their harmony: the action of the blood of the coronary arteries upon the fibres of the heart, and of the venous blood in the internal surfaces of the cavities of the heart. Recent experiments[2] have rendered this opinion of Boerhaave more than probable.

In 1752, Haller published his experiments upon irritability, which tended to establish the existence of an internal life independent of the nervous power, and demonstrated that the cause of animal motion resided in the muscular fibre itself. The opinion is now gaining ground with physiologists that the contraction of the muscles and all animal motions result from the chemical changes of the elements of the muscles and blood. Haller admitted that whilst the irritability of the muscles is the cause of all animal motions, it cannot produce them without a stimulus, and that the nervous power is the natural stimulus of all those which are submitted to the will, whilst the involuntary muscles acknowledge stimuli of various sorts, which are appropriate to their functions, and wholly abstracted from the nervous power. According to Haller, the blood is the natural stimulus of the irritability of the heart; and alimentary substances the natural stimuli of the intestinal canal: and the motions of these organs are not submitted to the will because they are independent of the nervous power. This theory of Haller, although imperfect, and in some respects erroneous, nevertheless expressed great truths which are now being demonstrated. Careful experiments demonstrate that Haller was in error when he asserted the independence of the heart and the intestines of the nervous system; and Prochaska,[3] in 1784, admitted the nervous power as one of the conditions necessary to the manifestation of irritability, and accounted for the fact that the motions of the heart were not stopped by the entire suppression of all communication between the brain and the heart, by the abandonment

[1] Her. Boerhaave Inst. Medicæ, § 409. Vanswieten in Aphorismis, &c. Lugduni Batav., 1745. Tom. ii.

[2] Brown-Séquard.

[3] Commentatio de Functionibus Systematis Nervosi, 1784.

of the then generally received opinion that the brain was the centre and only source of the nervous power, and by the adoption of the opinion that the nervous power is produced in the whole extent of the nervous system, even in the smallest nerves, and that it can exist independently of the brain, for a certain time.

Willis[1] and Vieussens[2] acknowledged the general relations of the sympathetic system with the cerebro-spinal, and considered the sympathetic as the medium by which the sympathetic relation is rendered so remarkable between the cerebrum and the viscera of the middle and lower parts of the abdomen, and noticed the important physiological and pathological facts that not only do the various conditions of the brain affect the viscera, but the affections of the viscera affect the brain as well as the mind itself.

The observations and researches of Winslow,[3] Girardi,[4] Fontana,[4] Jacobson,[5] Lobstein,[6] Ribes,[7] Killian,[8] Laumonier,[9] Cloquet,[10] Scarpa, Hasse, and others, established the structure and distribution and communications of the sympathetic system of nerves, and laid the foundations for the philosophical generalizations of the physiological and pathological phenomena.

Scarpa demonstrated by actual experiments, that the sympathetic system receives nerves from all parts of the nervous system, the brain and spinal marrow, and that all the viscera receive nerves composed of many separate filaments from different sources.

Würtzel divided all the ganglia of the sympathetic system into three orders, the cerebral, spinal, and vegetative, and affirmed that they differed essentially from each other in their structure, and in their behavior under the action of chemical agents.

Prochaska distinguished the nerves of motion from those of sensation, and affirmed that the heart cannot contract itself, unless the impression of the stimulus upon its cavities is transmitted to the ganglions of the system of vegetative life, through the nerves of

[1] Nervorum Descriptio et Usus. Cap. xxvi. Opera Omnia. Genevæ, 1695, tome i.

[2] Neurograph. Univers., lib. 3 de Nervis, cap. v.

[3] Exposition Anatomique, Traité des Nerfs.

[4] Journal de Médecine, Chir. et Pharm., par Bacher, tom. xciii.

[5] Acta regiæ Societatis Hafniensis Medicæ, vol. v. Hafniæ.

[6] Structure, Functions, and Diseases of the Sympathetic Nerve, by J. F. Lobstein. Trans. by J. Pancoast. Phila., 1831.

[7] Dictionnaire des Sciences Médicales, tom. lvi.

[8] Anatomische Untersuchung uber das Neunte Hirnnervenpaar, Pesth, 1822.

[9] Journal de Médecine, Chirurgie et Pharmacie, par Bacher, tom. xciii.

[10] Traité d'Anatomie Descriptive, tom. ii.

sensation, and thence reflected to the fibres of the heart, through the nerves of motion. Whilst admitting the connection of the sympathetic system with the action of the heart, he is confused and uncertain in his account of the functions of the ganglions, which he appeared to consider as knots and ligatures, tight enough to intercept all communication in the calm and quiet state, but not sufficiently tight to prevent the action of the nervous force, generated in the brain during the agitation of the passions. He asserted that it is through the nerves of the eighth pair that the effect of the passions is felt upon the heart.

In common with Winslow, Wintrel, Johnstone, and others, Prochaska believed that the ganglia of the sympathetic system were so many little brains capable of supplying the necessary nervous force to the viscera.

Bichat acknowledged an animal and organic life distinct from each other, and affirmed that the system of ganglions (sympathetic system) belonged entirely to the organic life, and that the cerebral system belonged entirely to the animal.

Whilst Bichat understood the influence of the several parts of the nervous systems, he failed to recognize their mutual connections. The mutual relations of these systems were established by the exact and philosophical experiments of Le Gallois.[1]

[1] In his work, which was pronounced by Humboldt, Halle, and Percy, the commissioners of the French Institute to whom it was referred, "the most important physiological work that had been produced since the learned experiments of Haller—the most unexampled work in physiology, every part of which is so connected and so dependent upon each other, that to arrive at the perfect explanation of a fact, it is necessary to reascend to all those by which the author had arrived at it; and that no one deduction can be denied, without denying all the preceding ones, or raising a doubt respecting those which follow." Le Gallois, by an extensive series of experiments, arrived at the following conclusions:—

"Life is produced by an impression of the arterial blood made upon the brain and medulla spinalis, or by a principle resulting from this impression.

"The prolongation of life depends upon the continual renewal of this impression. The property of the principle in question to survive wounds, and a very considerable destruction of the rest of the body, provided its peculiar seat has not been injured, affords a ready criterion for determining in what part of the nervous apparatus the primum mobile of such a function resides. For whenever, by destroying a certain portion either of the brain or of the spinal marrow, you cause the cessation of a function suddenly, and before the known period when it would cease naturally, you may be assured that this function depends upon the part that has been destroyed. It was in this manner that I discovered that the primum mobile of respiration had its seat in that part of the medulla oblongata which gives rise to the nerves of the eighth pair; and it is by pursuing this mode, that one might,

The results of the experiments of Le Gallois were confirmed and extended by the minute, elaborated, and extensive anatomical,

to a certain degree, discover the use of certain parts of the brain, so much the object of speculation, but hitherto only defined in systems produced by a lively imagination. . .

"It is this impression, this principle formed in the brain and spinal marrow, which, under the name of nervous power, and through the medium of the nerves, animates all the rest of the body, and presides over all its functions.

"The heart derives all its powers from this principle, as do all the other parts, the sensation and motion with which they are endowed, with this difference, that the heart derives its power from every point of the spinal marrow, without exception, whilst every part of the body is only animated by a portion of that medulla (by that which is supplied with nerves); a difference which may serve to explain the intensity of the power of the heart, and its uninterrupted continuance, from the moment of conception, till the hour of death.

"From the great sympathetic nerve, the heart receives its principal nervous filaments; and it is only through that nerve, that it can receive its energy from every point of the spinal marrow. The great sympathetic must, therefore, have its origin in this medulla; and thence the numerous questions that have been raised on the origin of this nerve, namely, whether it proceeds from the brain or from the spinal marrow; or, as Bichat pretends, whether those different portions are only branches communicating from the ganglions, which this author considers as so many smaller brains, forming a distinct nervous system, independent of the brain and the spinal marrow. All these questions, hitherto inexplicable in anatomy, are completely determined by experiments. . .

"From the same principle, we can no longer admit the assertion of Bichat, though pretty generally adopted, that there is in the same individual two distinct lives, one animal, the other organic; that the brain is the only centre of animal life; and that the heart, independent of the brain and of the nervous power, is the centre of life.

"It must, however, be observed, that there is a real and a very important distinction to be made between the organs that receive their nerves from the great sympathetic, and those which receive theirs immediately from the medulla oblongata and spinal marrow.

"The former receive their principle of action from the whole nervous power; their functions are not submitted to the will; they are exercised in every instant of life, and, at most, suffer only remissions.

"The latter, on the contrary, have their principle of action in a limited portion of the nervous power; their functions are submitted to the will; they are temporary, and can only be repeated after complete intermissions of longer or shorter duration.

"This distinction comprises nearly the same organs as that of the two lives; but it is evident that it rests upon a basis entirely different, since the organs of organic life, which, in the system of the two lives, is considered as independent of the brain and of the spinal marrow, are precisely those which receive the most powerful influence from it.

"Numerous anatomical, physiological, and pathological facts can only be conceived and accounted for by this distinction. For instance, it is known that certain pains in the bowels cause debility, prostration of strength, and great disorder

physiological, and pathological researches of Lobstein,[1] who anticipated many of the results of recent experiments and research.

throughout the animal economy. This fact, which is unaccountable in the system of the two lives, is readily understood, from the moment we reflect that the intestines derive their principle of action from all parts of the nervous power, through the great sympathetic, from which they receive their nerves; and that consequently, their affections ought to react immediately upon every part of this same power."

"Experiments on the Principle of Life, and particularly on the Principle of the Motions of the Heart, and of the Seat of the Principle," by M. Le Gallois, M. D. P. Translated by N. C. and J. G. Nancrede, M. D., Philadelphia, 1813, pp. 142–148.

[1] The following quotations from the elaborate work of Lobstein upon the *Structure, Function, and Diseases of the Sympathetic Nerve* embody the most important results and generalizations established by this author, and illustrate in a forcible manner the relations between the cerebro-spinal and sympathetic systems. The author sums up in the following manner the theories of Reil and others:—

"The cerebral nervous system is formed differently from that of the sympathetic system. The branches of the former converge from the periphery of the body towards the cerebrum, and are inserted into it by their roots, as the roots of vegetables are in the soil; that system, therefore, has but one centre, which is in the encephalon. The latter, on the contrary, is not collected into any centre; it has no focus of action, but exercises its functions over a wide surface.

"The sympathetic system connects the organs together in three different modes. 1. It forms networks around the vessels, which embrace the arteries with their slender and minute branchlets (as the ivy clasps the stem of a tree), and penetrates with them to the organs. These networks are known under the name of plexuses, twelve of which are enumerated, appertaining to different parts. * * * 2. These plexuses are connected to the brain and medulla spinalis by branches which Reil calls conductors. * * * 3. These branches, the conductors of the plexuses, appear to form a perfect connection between the animal and vegetable systems; every commotion which the lower viscera suffer would be conveyed to the sensorium commune, and *vice versa*—the will would exercise a perfect control over the organs of the thorax and abdomen, were not these movements intercepted by enlargements in the conductors called ganglia."—pp. 72, 73.

"When the two nervous systems by which the animal is rendered more perfect are considered physiologically, each may be esteemed a sphere of activity in which the vital actions are differently performed. In the animal sphere (that is, in the cerebrum, the medulla spinalis, and their nerves) the determination of the will and senses, when transferred to the common sensorium, become impressions instanter, and, as it were, at a single impulse. In the vegetative sphere the nervous energy is slowly, steadily, but obscurely, dispersed into the organs. These are connected together, act according to their peculiar laws, and compose a system separate from the animal sphere, over which appropriate laws preside. This system also possesses the faculty of perception—namely, it receives impressions, and reacts upon them; but this perception abides in its own region, and is not communicated to the brain. In a healthy state, the system of ganglia exerts no manifold influence upon the cerebral system, from which it is divided by the separatory or isolating apparatus, the series of ganglia in the sympathetic nerve. But the case is different in a state of disease, for when the vital energy is increased in the communicating nerves of the plexuses, the condition of the ganglia is changed; they

transmit impressions which the extremities of the nerves in the viscera receive, and become conductors, whilst before they were non-conductors or isolators." * * —pp. 74, 75.

"In the fœtus none but the sympathetic nerve is in vigorous action; it exists previous to the secretory and nutrient organs; it sustains the energy of the heart; and breaks in sometimes upon the cerebral sphere, and determines those automatic motions which the infant, when closed in the uterus, performs with its muscles. Acephalous fœtuses, destitute of cerebral and spinal medulla, and hence wanting the nervous centre from which emanates the principle of muscular contractions, perform, nevertheless, muscular movements which can be in no other way excited than by the vital influence of the sympathetic nerve, which is joined by an anastomosis with the spinal nerves."—p. 77.

"During the extra-uterine life of man, when there exists some immediate internal sense inherent to the stomach, this nerve forms a remarkable intercourse between the cerebrum and the viscera of the thorax and abdomen, as is proved by numberless phenomena. Then, as in the embryo and fœtus, it governs the system of capillary vessels, and directs the functions of assimilation and nutrition, through the influence of the vital plastic power, which Broussais calls vital chemistry." * * —p. 77.

After this general statement of the theories broached and facts established by others, Lobstein proceeds to give the results of his own investigations.

"No one will certainly deny that there exists in animals a certain central influence with which the duration of life is intimately connected. No one will deny that this central influence is inherent, not to the osseous, vascular, or muscular systems, or nutrient organs, but to that initial system which is nobler than the rest, and involves the first character of animality, and after removal of which all power perishes—viz., the nervous system."—p. 77.

After a careful examination of the origin and development of the nervous system in the animal kingdom, he concludes—

"1. That there is a nervous system in the invertebrate animals which is marked with ganglia. 2. That in the lowest order of these animals the first nervous mass found belongs to a nutrient organ. 3. That other tubercles are speedily added in animals a little superior in the scale, which are not dissimilar to the cerebral system.

"In animals of a superior order the motorial and sensorial ganglia of the organs are inflated, as it were, into one system, the cerebral, in which the gangliform figure disappears; so, on the other hand, the organs employed in nutrition are formed into a peculiar system in which the primitive arrangement and form of the nerves remain, and which (as in the lowest class of animals) closely surround the intestinal canal with their branches.

"According to a corollary of the greatest importance, there exists a relation between the sympathetic nerve and the par vagum—to wit, that one may take upon it the functions of the other; for in the inferior vertebrated animals the par vagum appears to be more prolific in branches distributed to the intestines, as the sympathetic nerve is less; and it is found that in some vertebrated animals no sympathetic nerve exists at all, and in which its functions are performed by the par vagum only. Whence it follows that the par vagum should be classed under the same law as the sympathetic itself, with the nerves of vegetative life. In fine, in all orders of animals the sympathetic nerve is always found, in regard to its development, to correspond with the pre-existing vascular apparatus; which proves that it owes its delicate construction to the wants of the vessels.

"A nervous system which exists in the lowest scale of animals is peculiar to the nutrient organs, and performs especial functions of its own, which, prior to the appearance of the brain, constituted a nervous centre, and which, when the cerebral centre is formed in animals, is inter-connected only, and never composes with it one undivided apparatus, but always retains its pristine form and habit—that such a system is endowed with the greatest functional importance is self-evident." —p. 81.

"As to the forces, the branches of the sympathetic nerve are undoubtedly endowed with the same power as nerves in general; that is, from the vital principle by which tone, strength, and energy are maintained in the organs over which they preside. It does not seem improbable that the ganglia which diversify the trunk ought to be considered as the laboratories of that principle, which the internal or egredient branches conduct to the viscera, and of the nature of which we are entirely unacquainted. In the cerebral voluntary nerves, as well as in the sympathetic nerve, the nervous principle traverses in both directions; to wit, from the trunk into the branches, and again from the branches into the trunk."—p. 82.

"But the branches of the sympathetic belong principally to the arteries which they envelop, while the finest filaments which follow the arterial branches into the organs are terminated in the external coat. Hence it is manifest that the vessels are primitively constituted under the government of the nerves, and that from them the force and energy are borrowed with which they operate in the functions of nutrition and secretion."—p. 83.

"From all that has been hitherto produced, we are at liberty to conclude that there is no essential difference between the sympathetic nerve and the encephalic mass and spinal nerves, but that the two nervous systems are so far distinct that both are peculiarly situated according to the different conditions in which they exist in the body.

"In the anatomical part of this treatise it was first demonstrated that the trunk, branches, and filaments of the sympathetic nerve have the same structure as the cerebral and spinal nerves, the same plexiform division, and, when examined with the microscope, the same composition; to wit, medulla and neurilemma. On the other hand, I know, from attentive observation, that the sympathetic nerve transmits the impressions it receives to the common sensorium in the same manner as the cerebral and spinal nerves. Thus an irritant afflicting the primæ viæ is perceived immediately by the brain, as the following demonstrates: 1. The tormina occurring in various diseases. 2. A calculus lodging in the biliary ducts, the pelvis of the kidneys, or the ureters. 3. An irritant near the hepatic plexus, from which an animal was seen to suffer by Haller. 4. The galvanic agent producing intense peristaltic motion, and secretion of the intestinal fluid, according to the experiments of Grapengeiser."—p. 87.

"The sympathetic nerve presides over the function of nutrition, not only because it imparts many nerves to the chylopoietic organs, and sustains their energy and influence, but because it is also distributed to the arteries, which carry the nutrient blood.

"Let us suppose the nervous power destroyed in the abdominal plexuses; the tone of the stomach, gastric, and intestinal digestion, and the functions of the liver and spleen would be impaired.

"That this indeed may take place, is taught by numberless instances of mental disease, which, when thrown upon the solar plexus, suddenly disturbs the whole function of digestion.

"The abnormal action of the abdominal nerves exercises an influence over the

organs, in regions very distant from each other, from which it is manifest that the functions of assimilation and nutrition are under its subjection. Recently one of my intimate friends, who is about thirty years of age, after being suddenly terrified by the burning of his house, had his hair to turn white in the course of a few days. Was it not the mental suffering he experienced, which, by the unanimous consent of physiologists, deranges the abdominal nerves, that in this case produced the change by disordering the force and functions of these nerves? and did not this disordered action affect the nutrition of the capillaries?

"Physiologists have long since acknowledged the great influence of the nerves over the capillary and nutrient vessels. Thus, if it is enhanced, the action of the latter is increased; if diminished, weakened; if utterly deficient, destroyed; hence it is as they are maintained to supply this office, that they have not any control beyond it. Is it not then evident, that when the nerves are injured, nutrition would be frequently destroyed? The experiments of Dupuy upon horses, in which the superior cervical ganglia were cut away from either side, furnish good proof of this; contraction of the pupil, redness of the conjunctiva (phenomena since observed by F. Petit), emaciation of the whole body, œdema of the feet, and an universal cutaneous inflammation followed the operation."—pp. 89, 90.

"What I have said of nutrition in general, holds good in the secretions of the fluids, because the same mechanism supports secretion."—p. 91.

"As we are considering physiological and pathological phenomena, we will ask if there be any ignorant that the secretion of the fluids in the glands may be increased by the effects of the imagination alone.

"Who can deny that the maternal milk, the bland and sweet nutriment of infants, has been suddenly changed by mental affections to an atrocious poison? No other instruments certainly exist but the nerves, by whose aid the psychological irritant can act upon the organs.

"The sympathetic nerve governs the action of the heart and the circulation of the blood.

"The cardiac nerves have the same relation to the fibres of the heart, as the cerebral and spinal nerves with the voluntary muscles."—pp. 92–93.

"The sympathetic nerve forms an admirable chain of connection between the principal organs of the human body." This proved anatomically and psychologically and pathologically. "The sympathetic action is by no means circumscribed to the cavity of the abdomen; on the contrary, it spreads itself wider, and connects the separate parts of the body in close union with itself.

"*Most of the phenomena, indeed, may be considered as consensual, in which the sympathy is proved to arise from the connection and interlacing of the nerves.* 1*st. Titillation of the nose produces sneezing, because the nasal nerves of the spheno-palatine ganglion are connected through the medium of the deep-seated and superficial vidian nerves, with the sympathetic; from which the diaphragmatic plexus arises, which is joined by anastomosis of the phrenic nerve.* 2*d. An intense light also excites sneezing, for the impression being perceived by the retina, and transferred instantly to the ciliary nerves, is conveyed to the sympathetic, and by the nasal branch, and the remaining nasal nerves of the fifth pair.* 3*d. The anastomosis of this nerve (sympathetic) with the fifth pair, accounts for the gritting of the teeth, and itching of the nose, in the verminose diseases of children; renal calculi, or nephritis, produce vomiting, or other disorders of the stomach, whilst the stimulating cause, if confined to the bladder, rarely excites gastric derangement.* For the nervous communications are more conspicuous and more numerous between the kidneys and stomach, than between the stomach and urinary bladder. 5. The observations of celebrated practitioners instruct us, that

many laboring under diseases of the abdominal viscera, suffer cloudiness of vision, that the retina is also drawn into consent."—pp. 96, 97.

"*But the medium through which the connection of the nerves is chiefly made, is the par vagum, the principal anastomoses of which with the intercostal nerve, in the neck, thorax, and abdomen, form many plexuses, upon which the action of the sympathetic nerve depends, and through the medium of which, chiefly, that admirable intercourse exists between the head and abdomen, known to physicians in all ages.*"—p. 97.

"In this respect the fascia communicans of Wrisberg is of great importance, and which, in my judgment, might be more aptly named, the great abdomino-cephalic anastomotic branch, for by it the animal life is connected with the nutrient or vegetative, so that the mutations of one may be immediately felt within the domains of the other, perceived by the mind, and *vice versa*. I shall allege some cases of abdominal disease in the third section of this work, in which this sympathy is sufficiently manifest in the morbid state."—p. 98.

"The route by which the descending or ascending impression goes and returns, is none other than the abdominal fascia, or the abdomino-cephalic anastomotic branch. This alone, and uninterrupted by ganglia, forms the immediate intercourse between the cerebrum and abdomen."—p. 99.

"In reflecting upon the nature of intermittent fevers, I have thought that it might, perhaps, be found in the disorder and perverted action of the abdominal nervous system, and there appear, indeed, to be sufficient grounds to render this opinion probable." * * *—p. 121.

"The paroxysms of intermittent fever are tied down to a regular rhythmus, in consequence of their being radicated in the nervous system, upon which nature has impressed a law, according to which they must perform their functions periodically."—pp. 121, 122.

"Each nervous system, therefore, is obnoxious to its own diseases. But the mode in which the cerebral and spinal nerves, and the nerves of the abdominal plexuses and ganglia are affected by disease, is the same. As in the various kinds of convulsions, epilepsy, tetanus, etc., there is disorder in the voluntary nerves, even when no organic lesion can be discovered in them; so the nerves of the thoracic and abdominal viscera may be affected without any alteration perceptible to the senses. As the perverted action of the cephalic brain is reflected with great force upon the abdominal brain, so in turn does the latter react upon and overwhelm the former; and finally as the cerebral system, when it is stupefied, as it were, by the violence of disease, destroys life, in like manner, I believe, an analogous effect takes place in certain diseases in the solar plexus."—p. 122. Connection of the sympathetic and cerebro-spinal systems, illustrated by numerous pathological conditions. Effect of blow upon epigastrium, p. 122. Effects of the recession of miliary exanthemata in producing abdominal paralysis or apoplexy, hemicrania excited by hypochondria and hysteria, p. 122. Relations of affections of the head to the state of the ganglionic system and the bowels, pp. 124, 125. Explanation of delirium and of the action of cathartics in modifying the phenomena of fever, pp. 122, 125–6. "Sympathy between the teeth and abdominal nerves," p. 127.

"*The perverted action of the brain is by no means circumscribed to the cavity of the cranium; it is extended to distant regions of the body, whence organic diseases are produced.*

"*After lesions of the brain there is undoubtedlg a dynamic disorder of the nervous apparatus of the liver, antecedent to the inflammation and suppuration of that organ. Various hypotheses have been invented to explain the connection between the brain and hepatic system, none of which have yet been at all satisfactory. I may with better rea-*

The physiological and pathological relations of the sympathetic and cerebro-spinal nervous systems have also been subjects of elaborate investigation, by Dr. Samuel Jackson,[1] Professor of the Institutes of Medicine in the University of Pennsylvania.

son, refer it to a communication of the right par vagum with the solar plexus, by which the cerebrum is connected to the right semilunar ganglion, from whence emanate directly the posterior nerves."—pp. 131, 132.

Lobstein illustrated the relations of the sympathetic and cerebral system of nerves, and also the connection of the nervous system with diseases, by numerous pathological facts. The notes added by Dr. Joseph Pancoast also contain interesting corroborative facts.

"A Treatise on the Structure, Functions, and Diseases of the Human Sympathetic Nerve," by John Fred. Lobstein. Translated from the Latin, with notes, by Joseph Pancoast, M. D., Philadelphia, 1831.

[1] The following quotations from his work on the Principles of Medicine, published more than a quarter of a century ago, will show that his views are profound expressions of those relations of the nervous system which are just now being recognized by the profession:—

"Considerations, based on the anatomical structure, lead to the following inferences as to the functions of the ganglionic system:—

a. "It is not independent of the cerebro-spinal nervous system, but derives its nervous activity from its connection with that system.

b. "It is connected throughout its whole extent by the numerous nervous filaments passing from one ganglion to another, and uniting together the different plexuses.

c. "The organs of the head, neck, thorax, and abdomen, with the genital organs, which receive nervous filaments from this system, are placed in a communion of actions and impressions, which are transmitted from one to the other, and it is thus the principal instrument of the sympathies between those organs.

d. "Supplying the thoracic and abdominal viscera and genital organs with nerves, and communicating with the cerebro-spinal nervous system, it is the medium of communication between these organs and the nervous system of relation.

e. "Supplying the abdominal and thoracic viscera and genital organs with numerous nerves, this system must be the chief agent in maintaining the exercise of their functions.

f. "From the quantity of nerves which it distributes to the arteries, the closeness with which these vessels are invested with those nervous filaments, and which are lost in their coats, it must exercise an active agency over their circulation, and in this manner influence the secretions and nutrition.

g. "The muscles that receive nervous filaments from this system have this peculiarity, that they act without volition, or even consciousness. They must, consequently, receive the nervous stimulation for this purpose from the ganglionic system."—p. 37.

"From physiological and pathological facts we derive a confirmation of these principles, and obtain additional light in arriving at a knowledge of the fuuctions of this system." * * *—p. 37.

"The ganglionic system furnishing the principal nervous supply to the surfaces, where are seated the instinctive wants of the organism, we have in the above facts:

1st, that the ganglionic system is the nervous apparatus of the instincts and internal senses ; 2d, that it communicates to the nervous system of animal life or relation the wants of the economy ; and 3d, is capable of compelling that system to command the acts necessary to supply these wants.

"The interrogation of pathological phenomena will furnish additional elucidation to this subject.

"Irritations excited in the mucous tissue of the stomach and small intestines by the impressions of irritating agents, will excite irritations in the brain, and sometimes spinal marrow.

"The acute inflammations of the gastro-intestinal mucous tissue rarely, it may be asserted never, fail to occasion cerebral or spinal inflammation. Hence, they are invariably attended with headache and delirium, pains in the back, and often neuralgic pains in the extremities ; they frequently occasion coma, apoplexy, hydrocephalus, convulsions, and paralysis. The chronic inflammations of the same tissue are also productive of chronic inflammations of the cerebral organs, and hence we find mania, monomania, catalepsy, and hysteria, are frequently connected with that state of the digestive organs. The connection between the cerebro-spinal organs and the mucous tissue of the stomach and small intestines, by which the actions of the one are transmitted to the other, is most probably effected through the nerves of the ganglionic system, and the inosculation of the solar plexus with the par vagum." * * *—p. 40.

"None of the viscera that are placed under the influence of the ganglionic system of nerves, exercise so decisive and prominent an action over the cerebro-spinal nervous organs as the stomach and small intestines, especially the stomach.

"With less promptness and less constancy the other organs in this connection respond to the morbid irritation of the gastric mucous surface. An example is afforded in acute gastritis, in which the eye is always injected with blood, the fauces and tongue are arid and inflamed, the lungs often partake of the disorder, and respiration is impaired or deranged. The liver, the kidneys, the genital organs, all display more or less of disturbance in their functions, corresponding to the degree of the gastric disease. The acute irritation of these organs are attended, in a like mode, with disorder and disturbance of the stomach and its functions. Thus, inflammation of the kidneys, uterus, liver, and sometimes of the eye, is productive of an irritable state of the stomach, exciting nausea and vomiting.

"The above pathological phenomena exhibit: first, a close connection between the stomach and the brain, by which they mutually reflect their irritations on each other ; and second, that the different organs to which the ganglionic system sends nerves possess a free communion in their actions, which is most extensive and active between those organs most abundantly supplied with nerves.

"The ganglionic system, from these facts, would appear to be the medium of the sympathies that bind together the viscera of the splanchnic cavities—the cranium, thorax, abdomen, and the genital organs." * * *—pp. 40–42.

"While it cannot be doubted that the organs of the moral faculties and passions are situated in the brain, neither can it be denied that the viscera are not entirely passive in their exercise.

"What is the exact part they perform, it is not easy to divine ; but every one is conscious of sensations of a peculiar kind, having either a pleasurable or painful character, experienced in the epigastrium, in the chest, and sometimes in other parts, while under the influence of moral emotions of an agreeable or distressing nature.

"The participation of different organs of the thoracic and abdominal viscera in

the actions which constitute the passions, is evidenced in the secretion of tears, or weeping in sorrow; sobbing in grief; the tremulous voice, or its total loss, with tremors of the muscular system in fear; laughter in joy; gaping in ennui; the injected eye; hurried breathing and quickened action of the heart in violent anger and rage, when uncombined with apprehensions; and in the gastric stricture experienced in the preceding painful emotions, as also in hatred, jealousy, &c., with often the copious secretion of bile.

"These effects most distinctly indicate the extension of the cerebral actions, roused by the passions or affective faculties to the physical organs of the economy.

"These organs, on the other hand, are observed to hold a decided power over the exercise of the passions, and to control their elicitation.

"A state of inflammatory excitement or irritation in those organs opposes the gentle visceral excitement of the pleasurable passions, and they can be no longer experienced. When the stomach and thoracic organs are inflamed, it is not possible, even in those whose natural disposition inclines them to gayety, to excite feelings of that character or to provoke laughter. Joy, hope, and all the animating moral impressions, are dissipated, and the mind is plunged into gloom, depression, and despair. The chronic irritation of the digestive viscera is the most common cause of melancholy and hypochondriasis. Irritations of the digestive apparatus are often directed on the cerebral organs, and, by exciting irritation in them, carry a positive influence into the development of the passions. Thus irritations in the stomach metamorphose frequently the temper and character; the gentle and mild become peevish and irritable, the gay morose, the fearful bold, the coward courageous, the merciful cruel. The irritations occasioned by ardent spirits in the stomach and brain give rise to the frequent quarrels and disputes about trifles when this pernicious habit is indulged, and the man who when sober is an affectionate husband, a tender parent, a faithful friend, when under the influence of intoxication is converted into a savage, unfeeling brute; he is borne away by the most terrible and furious emotions; he is no longer master of his actions, and is scarcely conscious of the excesses he perpetrates." * * *—pp. 193, 194.

"Sympathy is the medium connecting the organic actions of the different organs, and consists in the transmission to a remote organ, and the repetition in that organ, of the same mode of action which had been previously excited in some other organ. One organ is in this manner an exciter or stimulant to the actions of other organs, and concurs by this means to the maintenance of the vital activity of the whole organism. * * *

"The improvement of physiological knowledge, by determining in a more precise manner the offices of the different tissues and organs, renders it certain that the nervous apparatus alone is capable of producing the phenomena to which the term sympathy is applicable." * * *—p. 590.

"In the senses we have the positive demonstration of the transmission of impression from one organ to another distant organ. * * * A reciprocity and identity of action, it is apparent, prevails between the organs of the senses on the external surface, the recipients of external impressions, and the internal cerebral organs; an action excited in the one being transmitted to and repeated in the other. * * * In this example of the senses we have presented a series of phenomena corresponding exactly with those constituting the sympathies—an action excited in one organ transmitted to and reiterated in another.

"Illustrations of a yet stronger character are furnished by the phenomena of the nervous apparatus, exemplifying in a more vivid light the character and mode of production of the sympathies.

"A mental impression, an idea, the excitation of a moral emotion, excites or modifies the movements of the capillary circulation, or disturbs the regular function of some important organ. The deep suffusion of the mantling blood in the face of the modest female, the eloquent language of the unuttered thought, is a striking exemplification of the influence of cerebral excitement over the capillary circulation. The effects of the passions on the heart, so frequently disturbed in its mode of action by moral emotions; the disorders of the biliary secretion, and derangement of the digestive action of the stomach, induced by profound mental operations, are strong evidences of the transport of impressions by the nervous system. A still more impressive example is found in the erotic ideas in dreams, so stimulating the genital organs as to provoke in them the actual sensations of the venereal act, and the ejaculation of the seminal liquor.

"In these examples is manifested an excitement transmitted by nervous communication from one organ, in which it is developed, to another organ, to which it is transported, and to which it is imparted." * * *—p. 592.

"The power of transmission is common to all the nervous apparatus, and is the means connecting its different portions. But for the transmission of the excitement of the organic actions a specific nervous apparatus is provided; it is the ganglionic system, or the sympathetic—the nervous system of the viscera and organic life. By the arrangement and distribution of this system a nervous apparatus is provided, independent of, yet most intimately connected with, the cerebro-spinal nervous system. It is endowed with the same force, nervous activity, fluid, or whatever name it may be known by. It possesses an analogous mechanism; nervous organs or centres (the ganglia), nervous cords of communication or of transmission, and receptive expansions in the viscera. Its actions and influences are in a similar mode—impressions received, excitement of nervous activity, and transmission of excitement; and it exercises a controlling and governing influence over all the splanchnic viscera, to which it is distributed, similar to that excited by the cerebro-spinal apparatus over the organs of locomotion, expression, sensation, the intellectual and moral faculties." * * *—pp. 592, 593.

"The two important centres which have been indicated as existing in the nervous system are immediately connected to each other, and by this connection the two apparatuses are placed in communication, and direct relations established between them. This communication is established by the eighth pair, par vagum, or pneumogastric. Arising from the medulla oblongata, it sends branches to the ganglia of the neck and thorax, but is principally expended in anastomoses with the solar plexus and semilunar ganglia; so that it may be either described as proceeding from these ganglia and terminating in the medulla oblongata, or, arising from this last, it terminates in the ganglia.

"The communication formed by the par vagum or pneumogastric between the centres—the medulla oblongata and semilunar ganglia—establishes the intimate relation and immediate connection uniting the two apparatuses of the nervous organs—the cerebro-spinal and ganglionic or organic. By this connection impressions are mutually reflected from the one apparatus into the other; and consequently the impressions of the viscera, especially those of the abdomen, which have no direct communication with the brain, reach that organ, while those viscera experience themselves modifications from the influence of cerebral excitement." * * * —pp. 594, 595.

"In the natural state of the organism the correlation and mutual play of the organs on each other, through the medium of the nervous system, and by the radiation of its ingenerated nervous activity, are not characterized by features so

The experiments of M. Claude Bernard,[1] E. Brown-Séquard,[2] and others, and the researches of Henry F. Campbell[3], Marshall

striking as to be readily seized on and established. They nevertheless do exist, and are what is to be understood properly of the synergia of writers. In the pathological state the evidences of this mode of connection and influence are too apparent to be misunderstood. The pathological phenomena are, however, no more than an exaggeration of the physiological phenomena. When an organ, in a state of active irritation or acute inflammation, acts on another and distant organ, affects it in the same manner, communicates its own condition, it is not that a connection is established which did not before prevail, or a mode of action and influence is brought into play which previously had no existence. The connection was already there; the action and influence already had being; and as from this natural or physiological connection and influence the organs harmonize and correspond to each other in health, so from the same cause are they participants of the same condition in disease. It is from this natural, fixed connection and influence that an organ pathologically excited, generating in itself, by the nervous elements of its structure, an excess of nervous activity, becomes a morbid or pathological excitant to the other organs embraced in the range of its nervous circle, or with which it is in most intimate nervous connection." * * *—pp. 599, 600.

After making extensive application of these physiological principles to the treatment of disease, Dr. Samuel Jackson institutes a profound analysis of the phenomena of fever, and closes his work in the following words, which reveal his high appreciation of the value of the knowledge of the relations of the nervous systems and organs:—

"The study of the connections of the organs, functional and sympathetic, is the complement of all physiological researches and the fulfilment of pathological investigations. The more profoundly they are examined, and the more clearly they are understood, with the greater facility will the production of morbid phenomena be comprehended, the mysteries that involve the pathological state be penetrated, and the perplexities proceeding from the complications and diversities of disease be unravelled. Let them never be forgotten by the practitioner when he stands by the bedside of the sick. This knowledge is the rock on which he must build, would he erect a system of treatment at once rational, safe, and efficient."*—p. 619.

[1] Leçons de Physiologie Expérimentale Appliquée à la Médecine. Par M. Claude Bernard. Paris.

[2] Experimental Researches applied to Physiology and Pathology. By E. Brown-Séquard. New York, 1853.

Experimental and Clinical Researches on the Physiology and Pathology of the Spinal Cord. Richmond, 1855.

[3] An Essay on the Influence of Dentition in producing Disease. By Henry F. Campbell, M. D., Demonstrator of Anatomy in the Medical College of Georgia. Southern Medical and Surgical Journal (new series), vol. vi., June, 1850, p. 321.

Transactions of the American Medical Association, vol. vi.

An Inquiry into the Nature of Typhoidal Fevers. Transactions of the American Medical Association, 1853.

Excito-Secretory System of Nerves. Transactions of the American Medical Asso-

* The Principles of Medicine, founded on the Structure and Functions of the Organism. By Samuel Jackson, M. D., Assistant to the Professor of the Institutes of Medicine and Clinical Medicine in the University of Pennsylvania, &c. &c. Philadelphia, 1832.

Hall,[1] and others, have still further extended the knowledge of the mutual relations of the sympathetic and cerebro-spinal nervous systems. But, after all that has been achieved by a host of devoted laborers, we have but the mere outlines of this vast subject, and our knowledge relates almost entirely to the most general and superficial phenomena.

The true relations of the nervous system to disease must be based not only upon the relations of the sympathetic system to the organs, and to circulation, respiration, secretion, excretion, and nutrition; and of the cerebro-spinal system to motion and sensation; and of the sympathetic system to the cerebro-spinal system; but also upon the relations of the intellectual faculties to the nervous system, and through the nervous system to circulation, respiration, secretion, nutrition, and excretion. If the views promulgated by Prochaska and Gall be true, that each faculty of the intellect is connected with a special portion of the brain as the organic, material condition of the associated faculty, then aberration of those faculties would point to organic or functional alterations of the corresponding portions of the brain, just as an aberration or loss of sensation would point to the functional or structural alterations of the nervous apparatus devoted to the reception and transmission of sensational impressions; just as an aberration or cessation of respiration would point to a structural or functional alteration existing either in the nerves or in the apparatus of respiration. Whether the views of Prochaska and Gall, and of their followers, the phrenologists, be true or false, it would be nevertheless true that if the action of the intellect, when manifested by motions or sensations or consciousness, is always attended by chemical and physical changes of the nervous structures, then aberrated intellectual action would point to organic or functional changes in the nervous system. As in the case of aberrated motion and sensation, and of secretion and excretion, circulation and respiration, the causes of the aberration may lie entirely without the nervous system, in chemical and physical changes of the blood, induced by the catalytic action of morbific agents, so also in the case of aberrated intellectual action it may arise from chemical and physical changes

ciation, 1857. Also, Essays on the Secretory and Excito-Secretory System of Nerves. By H. F. Campbell, M. D., Professor of Anatomy in the Medical College of Georgia, at Augusta, &c. Philadelphia, 1857.

[1] London Lancet (Amer. ed.), March, 1857.

in the blood arresting or altering the normal chemical changes of the organs of the intellect.

In all investigations into the causes and effects of disease, the pathologist should remember that the origin of the disease may be connected with derangements in the constituents of the blood and of all the organs, independent altogether of the nervous system. Thus in malarial fever the poison, whatever it be, destroys the blood-corpuscles, destroys the ferment in the blood which converts the animal starch elaborated in the liver into grape sugar, and produces profound alterations in the structures, blood, and secretions of the liver and spleen. Now, in the beginning, these effects may take place entirely independent of any alteration in the nervous system. In this case the nervous system will be secondarily affected, and its action seriously disturbed, and this disturbance will give rise to a distinct set of phenomena; but it is evident that the cause and origin of the disease lies back of this disturbance.

The study of the physician does not cease with these phenomena.

Whilst in the physical universe and in the structures of animated beings the phenomena are connected by determinate, definite relations, in the moral world there is a disturbing element acting contrary to all harmony. The history of the world presents a mournful picture of a strife between two great antagonistic principles of good and of evil. Every individual that is born into this world forms a fresh battle-field for the conflict of these principles. In his present state, man resembles the ruins of a majestic temple; those columns, though marred and broken, still retain enough of beauty and symmetry to remind us of its former grandeur; the inscription upon the wall of the innermost chamber, although covered with the damp and decay of ages, still points to a hand divine. The pleasant sentient emotions excited in the nervous system by benevolent actions and the strict adherence to truth, prove that the cultivation of the virtuous affections is favorable to health. While, on the other hand, the irritation, weakness, and morbid excitability of the nervous system produced by the indulgence of the evil passions, envy, jealousy, and revenge—the haggard countenance, the withered, blasted form of vice—prove that the indulgence of the principle of moral evil injures and wastes the body; prove that the intellectual and moral faculties act upon the material body by which they are environed; prove that the material body may be rendered unfit for the normal exercise of the moral and intel-

lectual faculties; prove that the knowledge of the physician should extend not merely to the physical, chemical, physiological, and pathological phenomena of the body, but should embrace the structure of the intellectual and moral faculties, and their relations to the material body by which they are environed.

It is evident, then, that the complete investigation of the origin, causes, effects, and treatment of disease demands an examination of the relations of man, during health and disease, to astronomical phenomena; demands an examination of the relations of man to the distribution of the terrestrial masses, to the soil, climate, and waters, not only at the present time, but in the past history of the relations of man to astronomical and terrestrial phenomena; demands an examination of the structure and relations and alterations of the solids and fluids of all the organs and systems of organs, and apparatuses, and tissues, and blood, and secretions, and excretions; demands an examination of all the physical and chemical changes, and the relations of the physical, chemical, vital, and nervous forces; demands an examination of the relations of the physiological and pathological alterations of the nervous system to secretion, excretion, sensation, motion, and intellectual and moral actions.

The pathologist and physiologist must necessarily be appalled by the immensity of the subject of his investigations; and he is inevitably disappointed by the imperfections of human knowledge, and by the imperfections of the instruments and methods of investigation. Thus, in attempting to account for the different manifestations of only one disease, we have not, in the present state of science, access to the most valuable data, such as the relations of astronomical, terrestrial, physiological, and pathological phenomena, and in the vast majority of the subjects of disease the effects of original constitutions, previous habits, and previous disease cannot be determined and eliminated from the general mass of results. It is probable that the course of severe diseases is always modified by the constitution, diet, occupation, and previous habits, whether virtuous or vicious, temperate or intemperate, and by previous diseases, and by the relations of the individual and his ancestors to the soil and climate. Thus we know that in a body of strong, healthy men, exposed to precisely the same sources of malarious disease, we may have manifestations of disease from a slight febrile excitement, scarcely deviating from the condition of health, down

to the most malignant type, commonly called congestive fever. If all have been alike exposed upon the same small ship, to the same poison, whence this difference? The difficulty and complexity of this problem, arising about a handful of mariners, may be comprehended when we state that, amongst many other things, its solution would demand a knowledge of the previous history of the physical, chemical, physiological, and moral influences of soil, climate, and disease upon the ancestors, and even upon the races; would demand a knowledge of all hereditary tendencies, peculiarities of temperament, and idiosyncrasy; would demand a knowledge of the relative activity and perfection of the individual organs and apparatus, and of the relations of these to each other; would demand a knowledge of the relations of the vital force to the matter of each organ and tissue and apparatus, and to the morbific agent or agents; would demand a knowledge of the action and reaction of the morbific matter upon the different forms of organized structure, and the consequent derangement of the physical, nervous, intellectual, and moral phenomena; would demand a knowledge of the relations of chemical action to the development of the physical and nervous forces, and the action of the intellectual and moral faculties; would demand a knowledge of the correlations of the physical, vital, nervous, intellectual, and moral phenomena; would demand a knowledge of the relations between physiological phenomena and the phenomena of the exterior universe. Every candid man will admit that the solution of such a problem is impossible at the present time, because the facts are wanting; and they will long be wanting, owing to the extreme complexity of the phenomena.

The imperfections of physiological and pathological investigations are placed in a clear light when we reflect that physiologists and pathologists scarcely recognize the relations between the physical, chemical, vital, and nervous forces; are not acquainted with many chemical changes going on in the body; know little or nothing about the origin and offices of some of the most important constituents of the blood, that great source of the materials of structure and chemical change; dispute about the offices of the spleen, supra-renal capsules, thymus and thyroid glands; and possess no absolutely accurate method of analyzing the blood, or of determining the amount and character of the products thrown off from the lungs and skin.

Whilst, therefore, we assert that the knowledge of pathological

phenomena necessarily includes a knowledge of the relations of all the phenomena of the universe, and affirm that the dignity and glory of a science should depend upon the multitude and complexity of its phenomena—whilst we express the hope that the day will come when the science of medicine shall be founded upon the immovable basis of inductive philosophy, and the world be compelled to recognize the truth that the solution of the problems of medicine requires a higher exercise of the reasoning faculties than the solution of the most complicated and difficult problems in physical and chemical science, a higher exercise of the reasoning faculties than the solution of even the grandest problems of astronomy—we would acknowledge that these physiological and pathological investigations which we are about to present are imperfect in many respects, and are merely beginnings in the right direction.

I shall be satisfied if they demonstrate the impossibility of the successful investigation of even the most striking phenomena of disease by a single individual, and lead to unity and concert of action amongst investigators.

CHAPTER III.

THE BLOOD.

Imperfect state of our knowledge of this fluid—Imperfections in our methods of analysis—Importance and difficulty of establishing a standard formula of the constitution of the blood in health—The composition of the blood varies, not only with the class, but with each species of animals, and corresponds with the development of the organs and apparatuses, illustrated by development of the blood and organs of invertebrate and vertebrate animals—Standard of Lehmann, and of Becquerel and Rodier—Importance of establishing the changes of the blood during thirst and starvation—Importance and difficulty of determining the amount of blood in the system.

In the present state of physiological and pathological science, the investigation of the changes of the blood in health and in disease is attended by great labor and numerous difficulties; and from the complexity of the substances, the number and delicacy and complexity of the chemical changes of these substances, and from the

numerous obscure and complex relations of these substances of the blood with the surrounding organs and tissues, and from the great imperfection of the methods and instruments of investigation, absolute accuracy is impossible. In view of the great labor and numerous difficulties and imperfections and absolute failures necessarily arising from the great complexity of the substances and phenomena, and from imperfections in the modes and instruments of investigation, and from the partial and imperfect nature of all the results of investigation thus far recorded, the profession is compelled to view with consideration even approximations to the truth. These statements are dictated neither by a spirit of exaggeration, nor by a desire to avoid criticism or to crave indulgence. They are true, because important questions with reference to the origin and offices of the most important constituents of the blood remain unsettled and involved in obscurity.

Whilst the physiological chemist knows that the elements of the blood are ultimately derived from the inorganic world (one portion directly and the other secondarily through the vegetable kingdom); whilst the chemist is able to investigate all the combinations and relations of these inorganic bodies out of the living organism; whilst the physicist can demonstrate the correlation and establish the mechanical equivalents of the forces generated during these chemical changes; while the physiologist can describe the general process of digestion, and the general superficial changes of the inorganic and organic materials during their preparation for the blood and structures; whilst the physiological chemist can isolate many of the constituents of the blood, and of the secretions formed from the blood; whilst the physiological chemist can isolate many of the substances resulting from the metamorphoses of the tissues and blood, and form plausible hypotheses with reference to the relations of these chemical changes to secretion, nutrition, and the development of the forces—still, the knowledge of the physiological chemist is incomplete, because numerous chemical changes have never been investigated, and his knowledge does not cover sufficient ground to allow the analysis, comparison, and generalization of all the physical, chemical, and physiological actions, or the determination of the origin, development, and metamorphoses, and physical, chemical, and physiological relations of each substance, or the determination of those fixed relations or laws by which it would be possible, not only to explain the correlation of the physical, chemical, vital, and nervous forces, but also predict with abso-

lute certainty the effects of disturbances in the chemical changes and in the development and mutual relations of the forces.

The imperfection of physiological and pathological science is placed in a clear light when we consider that the cause of the coagulation of the blood, the most striking and apparently simple phenomenon presented by this fluid, is still undetermined, notwithstanding the researches of Hewson, Hey, Prater, Hunter, Fordyce, Langish, Thackrah, Scudamore, Brücke, and Richardson; when we consider that the mode of origin and offices of fibrin are still matters of dispute, Zimmerman, Simon, and Inman considering it as an excretory product, of no further use in the animal economy, destined to be still further metamorphosed, and finally cast off, whilst Paget, Carpenter, and other physiologists regard it as the most perfect of the nutritious products destined to enter into the constitution of the organs and tissues; when we consider that the mode and place of origin, and the offices, and the mode and place of death and disintegration and excretion of the colored blood-corpuscles are still subjects of dispute and investigation with the best physiological chemists; when we consider that the mode of the formation of the secretions from the blood, and the connection of the nervous system with secretion, nutrition, and excretion, are undetermined, and are now engaging the attention of the best minds of the profession; when we consider that the series of chemical changes which the elements undergo during the nutrition of the organs and tissues, and during the development of the forces, are very imperfectly understood, if not wholly unknown; when we consider that the physical and chemical relations of the elements of the living body to the vast majority of poisonous compounds are unknown; when we consider that physiological and pathological knowledge extends merely to the time and place, and results of change, and not absolutely to the nature of the changes themselves; when we consider that no definite opinions prevail with reference to the relations of the physical, chemical, and nervous forces and phenomena with the vital and intellectual and moral principles. Should these imperfections in physiological and pathological science cause indolence and indifference? Should the complexity of the phenomena, and the imperfections in the instruments and modes of analysis, lead the honest inquirer after truth to abandon the investigation in despair?

The honest attempts to unravel complicated phenomena, by honest and truth loving minds who are not afraid or ashamed to

point out their failures, and the imperfections of their modes of investigation, and who ardently desire to incite others to investigation, and who would cheerfully destroy with their own hands every erroneous statement or hypothesis or theory which they have promulgated, have been and will often be characterized by the parasites and vultures of the medical profession, as failures, yea, even as dishonest failures, simply because they yield only negative results, or fail to elicit the whole truth.

In judging of the value of original investigations, we should at all times bear in mind the fact, that the development of all sciences has been the slow result of the labors of many minds, and that the rapidity of the development of each branch of knowledge has been in exact proportion to the complexity of the phenomena. Thus mathematics, and astronomy and mechanics, which deal with the most simple and general phenomena, were the first developed, and are now the most perfect of all sciences. As man stands upon a pyramid, the foundation of which is the inorganic world, and the materials composing this pyramid, consisting first of plants in various stages of development, the simpler extending downwards, the more complicated extending upwards, diminishing in numbers as they increase in complexity; and secondly of animals in various stages of development, increasing in complexity and diminishing in numbers as they extend upwards; and as the existence of man is absolutely dependent upon the relations of the component members of the universe; and as the forces of man are all the resultants of the action of the same forces of the sun which keep up a never ending circulation and change of the matter upon the surface of our globe; and as the development and action and life of man and of all organized beings depend upon the forces not only of our sun but also of the fixed stars, it is evident that he is a type of the universe and comprehends within himself all phenomena, astronomical, physical, chemical, physiological and psychological, and that his phenomena are exceedingly complex, and require for their complete solution the most laborious investigations and the most exalted exercise of the reasoning faculties. Notwithstanding, that from the complexity of the phenomena and the difficulties of the investigations, the progress of physiology and pathology must be slow; the observer, so far from being discouraged, should be animated to vigorous and prolonged effort, remembering that every honest physiological and pathological investigation must be productive of good, even if its results be only negative. Negative

results are always valuable, because they assist in defining the bounds of knowledge, and in determining the extent of man's power over the phenomena of nature, which depends absolutely upon his knowledge of the properties, forces, and relations and laws of matter.

Importance and Difficulty of Establishing a Standard Formula of the Constitution of the Blood in Health.

The blood is composed of so many and such different materials, and is liable to so many variations from causes entirely compatible with health, that the establishment of a reliable standard to which the changes of the blood in disease may be referred, is difficult if not impossible, and requires nice discrimination, laborious investigation, and wide generalization.

The blood is composed not alone of the elements of nutrition and secretion and force, it receives also the products of the disintegration of the tissues and organs, and the products resulting from the chemical changes of the elements used in working the apparatus, and in maintaining a definite temperature.

The elements of the blood may be furnished from the food and atmosphere alone, through the stomach, lungs, and skin; but the blood as blood, is the resultant of the elaboration of many organs, and of the chemical changes of all the organs and tissues.

The blood is not only distributed by innumerable channels through every recess of the body; the blood is not only the source of all the elements of structure; the blood not only furnishes the materials for all the secretions and excretions, and for all the chemical changes—but the blood is in turn affected by the physical and chemical changes of every vessel, of every nerve, of every organ and texture of the body. It is evident, then, that the constitution of the blood will depend upon the food; upon the vigor and perfection of the organs of digestion, respiration, circulation, and secretion and excretion; upon the vigor and perfection of the nervous system, and of all the organs and apparatus; and upon the correlation of the physical, vital, and nervous forces.

The character of the blood, then, will vary with the animal; with the organ and tissue through which it is circulating; with the age, sex, temperament, race, diet, previous habits, occupation, and previous diseases; with the soil and climate; and with the relative states of activity of the forces.

The constitution of the blood varies not only with the class but with each species of animals, and corresponds with the development and perfection of the organs and apparatus.

Thus, in the lowest forms of the protozoa, which resemble simple cells provided with vibratile ciliæ, we find no circulatory system; no fluid separated from the albuminous fluid which permeates the structures, to which the name blood may be applied; no special organs; and no nervous system. In the higher members of this group we discover the first rudiments of a circulatory system, and an attempt at the interchange of the fluids from different parts of the body. All the stomatoda have contractile pulsatory cavities situated in the denser and outer layers of the parenchyma of the body. During their expansion these cavities become filled with a clear, transparent, colorless liquid, which disappears entirely during the contraction. No bloodvessels communicate with these cavities, and no special walls have been discovered surrounding them; and the fluid which they contain, although analogous to blood, contains no corpuscles. By these simple means, corresponding to the structure of these animals, the fluids of the body are prevented from stagnation, and a free interchange of the nutritive elements promoted.

In the polypi—inarticulate fleshy bodies, having a simple visceral cavity, with a single opening at the centre above, without intestines, without glands separated from the walls of the visceral cavity, with no distinction of sex, and an imperfectly developed nervous system in the highest, and none whatever in the lowest—the circulatory system is rudimentary, and the fluid which it distributes nothing but the digested matters of the visceral cavity mixed with sea-water. This circulatory fluid contains a few spherical corpuscles, apparently albuminous, and a few oil-globules. According to Dr. T. Williams,[1] a few of these corpuscles appear to be nucleated, others appear to contain secondary cells, and others again are charged with minute granules. The fluid is incapable of coagulation, and contains albumen in very small amount.

In the highest species of the acalephæ the nervous system is more developed than that of the polyps, and the blood and circulatory system show a corresponding degree of development. The transparent gelatinous bodies of these animals are traversed by

[1] Memoir on the Blood-proper and Chylaqueous Fluid of Invertebrate Animals, by Dr. T. Williams, Philos. Transact., 1852; Brit. and For. Med.-Chir. Review, vol. xii. p. 484.

canals, which receive water from the stomach or directly from without, and being lined with ciliæ effect a constant renewal of the water, and thus perform the office of a respiratory system. These aquiferous canals are surrounded by vessels which have exceedingly thin walls, and are without ciliated epithelium and longitudinal and circular fibres, and which open directly by large tubes into the alimentary canal. In some species, according to Will, these sanguiferous vessels contain a greenish fluid, with spheroidal and slightly elongated red corpuscles with large nuclei; in others the corpuscles are brown, and in others again they are of a greenish color. There is no regular circulation, the blood being shifted hither and thither by the irregular contractions of the body. The blood of the acalephæ, although like that of the polyps, the direct product of digestion mixed with sea-water, is of a higher type, because its corpuscles are larger, contain more granules and oil-globules, and their cell-membranes are more distinct.

The higher members of the echinodermata have a distinct circulatory system separated from the alimentary canal, composed of arterial and nervous trunks, between which, in some species, there is an organ analogous to a heart. The echinodermata is the only class amongst the radiata in which a proper circulation of the nutritive fluid takes place, and this is attended with a corresponding development of the nervous and muscular systems and organs of secretion. It is in this class that we first find the liver in its rudimentary state, however, consisting of simple cæca, opening into the digestive cavity. According to Dr. T. Williams, the corpuscles resemble spherules, composed of hard and very minute granules of coagulated albumen, without any detectable nucleus or cell-wall, or oily particles, and are readily broken up into their individual molecules.

In the spiunculida, the highest order of this class, the corpuscles are more highly developed, being flat and irregularly oblong, having small, bright, highly refractive nuclei.

As the great object of these observations is to show that the constitution of the blood depends upon the development and perfection of the organs, and apparatus, and nervous system, and place in a clear light the great difficulty and complexity of the problem to establish a definite standard to which diseased blood may be referred, we will pass over the remaining classes of the invertebrata, and notice only the highest division of the mollusca, the cephalopoda.

The nervous system of the cephalopoda is highly developed, having a central portion resembling the brain of the vertebrata, in the extraordinary increase of its ganglionic substance, and in being contained in a cartilaginous cranium. They have a well-developed muscular system, and the rudiments of an internal skeleton, and all the organs, except the spleen, which are found in the vertebrata. They have organs of sense corresponding in perfection with the development of the nervous system; digestive apparatus complicated in structure; salivary glands highly developed; a pancreas present in some species; the liver present in all, and consisting of a compact glandular mass, with distinct excretory ducts; kidneys also present. The circulatory and respiratory systems exhibit a development, and the blood shows an elaboration corresponding to the perfection of the organs and apparatuses of the cephalopoda. It coagulates spontaneously upon standing, and the number of corpuscles is greatly increased. They inclose numerous granules, thus resembling the colorless corpuscles of the vertebrata. The majority of the blood-corpuscles are colorless; some few, scattered here and there, have a violet hue.

Blood of Vertebrate Animals.—In the amphioxus, or branchiostoma (Lancelot), the most simply constructed of vertebrate animals, the circulatory system resembles closely that of some of the Annelida, as the Eunice, in its division and the distribution of numerous pulsatile dilatations upon the different vascular trunks. The respiratory system is formed upon an equally degraded type. The branchial apparatus is placed in the same cavity in which are lodged the liver, kidneys, generative apparatus, and greater portion of the intestinal canal, thus resembling closely the invertebrata. The nervous and organic systems are correspondingly simple in structure. The canal which incloses the spinal column presents anteriorly no cranial expansion, but the spinal cord extends from one extremity to the other. The liver is reduced to its rudimentary condition, a greenish glandular layer lining a portion of the intestines, and the spleen is absent. Accompanying these simple undeveloped organs and feeble forces we find colorless blood, rich in water and poor in solid constituents. In the blood of this animal we find only colorless corpuscles. This is remarkable when we remember that the spleen also is absent. Colored corpuscles and a well developed spleen mark the more highly organized fishes.

We can assert that as far as our researches and experiments upon fishes have extended, the number of the colored blood-corpuscles, and the elaboration of the blood, and the rapidity of the development, and the energy of the forces, correspond to the development and perfection of the organs. Thus, in the Garfish (Lepisosteous osseus), which, in addition to branchial apparatus, has a capacious lung (opening by a short trachea and extending nearly the whole length of the abdominal cavity), we find a greater number of colored blood-corpuscles, and more active and vigorous forces. The Gar is a destructive and active pirate, and consequently needs great muscular power to outstrip and capture the swift inhabitants of the watery elements. Without the simultaneous development of the colored blood-corpuscles, and of the organs and apparatus, this would be impossible. We might demonstrate these propositions by numerous examples obtained by our own laborious investigations, but these will suffice to establish the truth of our propositions with reference to the class of fishes.

In the class of reptiles we find a similar development of the blood, corresponding to the development of the organs and nervous system, and the activity of the forces and intelligence. Thus, the blood of the doubtful reptiles, as the Congo Snake of our southern swamps and ricefields (Amphiuma means), and the Hellbender (Menopoma Alleganiensis), is thin, deficient in blood-corpuscles, and far less highly developed than the blood of the Alligator, or Chelonians.

In Birds and Mammalia we find a great increase of colored corpuscles, not only in quantity, but also in numbers. The size of the corpuscles are greatly diminished. The character of the blood varies in the different species, and even with the same; but the facts are as yet wanting which would enable us to introduce these elements with accuracy in the calculations destined to the establishment of a typical formula, to which the changes of the blood in disease may be referred.

The following table, drawn up by Lehmann[1] from his own analyses, and from the experiments and deductions of Schmidt, presents a comparison of the quantitative relations of the principal elements of the blood-cells and intercellular fluid:—

[1] Lehmann's Physiological Chemistry, English ed., vol. ii. p. 160; American ed., vol. i. p. 546.

1000 Parts of Moist Blood-Corpuscles contain—		1000 Parts of Liquor Sanguinis contain—	
Water	688.00	Water	902.90
Solid constituents	312.00	Solid constituents	97.10
Specific gravity	1088.50	Specific gravity	1028.00
Hæmatin	16.75	Fibrin	4.05
Globulin and cell-membrane	282.22	Albumen	78.84
Fat	2.31	Fat	1.72
Extractive matters	2.60	Extractive matters	3.94
Mineral substances (without iron)	8.12	Mineral substances	8.55
Chlorine	1.686	Chlorine	3.644
Sulphuric acid	0.066	Sulphuric acid	0.115
Phosphoric acid	1.134	Phosphoric acid	0.191
Potassium	3.328	Potassium	0.323
Sodium	1.052	Sodium	3.341
Oxygen	0.667	Oxygen	0.403
Phosphate of lime	0.114	Phosphate of lime	0.311
Phosphate of magnesia	0.073	Phosphate of magnesia	0.222

The following are the physiological limits of the variations of the constituents of the blood, as established by the researches of MM. Becquerel[1] and Rodier:—

In 1000 Parts of Blood—

The Water may vary		from	760.000	to	800.000
" Specific gravity of the blood may vary		"	1055.	"	1063.
" Globules	" "	"	120.000	"	150.000
" Fibrin	" "	"	2.000	"	3.500
" Solid matters of the serum	" "	"	90.000	"	105.000
" Cholesterine	" "	"	0.075	"	0.150
" Animal soap	" "	"	1.000	"	2.000
" Serolin	" "	"	0.010	"	0.030
" Chloride of sodium	" "	"	2.000	"	5.000
" Soluble salts	" "	"	1.500	"	4.000
" Phosphates	" "	"	0.500	"	1.000

In 1000 Parts of Serum—

The Specific gravity of the serum may vary		from	1027.	to	1032.
" Water of the serum	" "	"	880.000	"	900.000
" Solid matters	" "	"	100.000	"	120.000
" Albumen	" "	"	70.000	"	90.000

The following is the typical formula of the constitution of the blood in health, adopted by MM. Becquerel[2] and Rodier:—

[1] Pathological Chemistry of MM. Becquerel and Rodier, English ed., p. 90.
[2] Loc. cit., p. 81.

Analysis of 1000 Parts of Blood.	
Specific gravity of the blood	1060.000
Water	781.600
Globules	135.000
Albumen	70.000
Fibrin	2.500
Fatty matters, extractive matters, and free salts	10.000
Phosphates	0.550
Iron	0.350

Analysis of 1000 Parts of Serum.	
Specific gravity of serum	1028.000
Water	908.000
Albumen	80.000
Extractive matters and free salts	12.000

Notwithstanding the results of these laborious investigations, we must acknowledge that the establishment of an absolute standard, expressing the constitution of the blood in health, is impracticable, if not impossible. In the first place, we must not only establish a formula for each class and species of animal, and for the human race generally, but we must establish a formula for each temperament, and for each race and nation, under every conceivable circumstance of soil, climate, and occupation.

Another important field of investigation is the changes of the constituents of the blood during thirst and starvation.

In almost all the forms and grades of fevers the patients are deprived of food, either by the physician or by the condition of the digestive apparatus. Accompanying this condition we have rapid chemical changes, and often perverted nutrition. The constituents of the blood may be divided into two great classes, the nutritive and force elements. From the chemical changes of these two classes arises a third class, called the excrementitious. Now, both classes of matter, the force elements and the nutritive elements, are consumed, chemically altered, and converted into excrementitious offending compounds during starvation. In like manner both classes are converted into excrementitious compounds in fever. Now, to determine definitely what changes are due to fever, we must first determine what are due to starvation; that is, to the consumption of the blood during nutrition, and the generation of the forces by which the machinery is worked. This can only be accomplished by determining the changes of the blood during starvation, and the forces and products resulting from these chemical changes. A standard will thus be established, to which the changes in fever may be referred. In fever we have a pathological state (abnormal changes) superadded to those normally existing. We can never have accurate pathological knowledge until we determine the physiological changes. Another difficulty meets us:

The elements of the blood are liable to variations, not only of quality, but also of quantity. We must determine, not merely the relative variations, but also the quantitative. By analyzing the phenomena carefully, and attributing to each its just position, we may eliminate the elements of the problem only to a probable issue, we may determine the character of the changes and of the morbific agent; but the absolute amount of these changes will be unknown, without some method of determining the amount of blood in the system. Here, then, is a great and serious difficulty in the establishment of an absolute standard of comparison. We have no accurate means of determining the amount of blood circulating through the system. It is evident that obscurity on this point introduces obscurity everywhere, and impairs the value of every standard we may erect. The truth of this proposition is established by looking at the great discrepancies which have prevailed among physiologists, with regard to the amount of blood contained in the bodies of warm-blooded animals. Blumenbach estimated the quantity in an adult man at 8.5 to 11 pounds, Reil at 44, Haller computed it at 28 to 30, Borelli 20, Young 40, Dumas 25, Fletcher 30, Ancell 30. M. Valentin, by his method of injecting water, arrived at the following results. The numbers represent the relation existing between the quantity of blood and the weight of the body—

Large dogs (the mean of four experiments), as	1 : 4.5
A lean, debilitated sheep, as	1 : 5.02
Cats, female (the mean of two experiments), as	1 : 5.78
A large female rabbit, as	1 : 6.20

From these data he estimates the amount of human blood to be—

Male sex, as	1 : 4.36
Female sex, as	1 : 4.93

This would give in a man weighing 150 lbs. 30 lbs. of blood, and in a female weighing 130 lbs. 26 lbs. Lehman determined the amount of blood in the bodies of two criminals, who were decapitated, to be from 17.5 to nearly 19 lbs., or one-eighth the weight of their bodies. My own observations have established the fact, that the amount of blood varies with the different classes of animals, and corresponds with the rapidity of the chemical changes of the blood and tissues, and with the physical, vital, and nervous forces. These investigations have established that the blood is more abundant in warm than in cold-blooded animals. These facts are important in their bearing upon the phenomena of health and disease.

When we have a large supply of blood, and a rapid distribution of blood, then we will have a rapid generation of force.

In the present state of science we possess no method of determining absolutely the amount of blood existing in the animal body. Whilst we might determine the amount of blood contained in the large bloodvessels, it would be utterly impossible to determine the amount in the capillaries, because the quantity lost after fatal hemorrhage is no criterion whatever, and the latter portions drawn are also mixed with the fluids of the organs and tissues. Our knowledge on this subject is vague, and may be summed up in a few sentences. The young are said to have more blood than adults and the aged, and lean persons are said to have more blood than very fat persons. As in certain diseases there is a rapid destruction and perversion of the elements of the blood, and as it appears that these chemical changes are destined to fulfil certain salutary offices, as the destruction of peculiar poisons, it is evident that an increase or diminution of the blood, even within the limits of health, must modify not only the course of diseases, but also the action of remedial agents. The determination of an absolute standard is farther impossible, because in the piesent state of science the methods of analysis are not strictly accurate. We have no absolutely accurate method of determining the colored blood-corpuscles.

We have stated these difficulties, not with the design of casting doubt and discredit upon physiological and pathological science, but rather with the design of pointing out the great complexity of the phenomena, and defining the bounds of knowledge, and inducing caution both in investigation and in the generalization of the results of observation and experiment.

CHAPTER IV.

CHANGES OF THE BLOOD IN MALARIAL FEVER.

Color of the blood and serum in malarial fever and other diseases—Specific gravity and coagulation of the blood in malarial fever and other diseases—Fibrin decreases in malarial fever—Formation of heart-clots in congestive fever during life—Cause of the coagulation of the blood unknown—Chemical changes of the blood in malarial fever compared with the changes of the blood in other diseases—Blood-corpuscles are destroyed during malarial fever, and during the slow action of the poison, unattended with fever—Principles of treatment founded upon these changes—Time when these changes of the blood commence.

It is important that we should in the first place determine the extent and bearing of our means of investigation, and of our knowledge.

In the present state of physiological and pathological science, and methods of investigation, our knowledge of the changes of the blood during disease is limited to an examination of the venous blood of the extremities, or of the surface of the trunk. We have no means of investigating the changes of the blood in different organs and tissues during the different stages of disease.

The changes of the blood in the different organs can only be determined by an examination of the blood remaining in those organs after death. The information yielded by an examination of the blood of the extremities and surface of the trunk during life, and of the blood remaining in the organs after death, must be imperfect, because we can only superficially determine the composition of the blood at different stages of the disease, and are wholly unable to determine its changes in different organs and tissues, and apparatus, and are limited to an examination of the blood in the organs only after a fatal termination, and must, therefore, remain without the facts which would enable us to determine definitely the various steps of the chemical changes, and the physical, chemical, physiological, and toxicological action of the resulting compounds. The examination of the blood after death must always yield imperfect and unsatisfactory information, even with reference to the effects of the morbific agents upon the blood, immediately

preceding death, because in the hours of death, when the circulation and respiration are impeded, and the temperature diminished, and the nervous and vital influences enfeebled, many physical and chemical changes of the blood may result from the disturbances of the circulation and respiration, and from the alterations of the process of endosmose, and from the chemical changes of the organs and tissues through which the blood passes, entirely independent of the actions of the morbific agents.

In an examination of this kind it would be necessary first to establish a standard formula of the constitution of the blood in each organ, and tissue, and apparatus, by an examination of the blood after death, in the organs, and tissues, and apparatuses of those who had died in perfect health, and also during starvation. In the preceding chapter we demonstrated that the constitution of the blood varied with each animal, and in the human race varied with temperament, age, previous habits, diet, occupation, and previous diseases and race; and hence concluded that it was difficult if not impossible, to establish a universal typical formula of venous blood. It is evident, therefore, that the difficulties of establishing typical formulæ of the constitution of the blood in the various organs, and tissues, and apparatuses, would be increased a thousand fold.

Besides these difficulties, the poison or poisons which produce the changes of the blood in malarial fever have never been isolated, and we know nothing whatever concerning its physical, chemical, physiological, and pathological relations with the elements of the blood, and nervous system, and organs, and tissues by direct experiment. We can only infer them from the changes going on during the progress of the disease. So complicated are the phenomena, and so imperfect our knowledge of malarial fever, that we are unable to answer such important questions as these: Does the poison act by catalysis, by its mere presence in the blood, inducing a series of chemical changes, which result in the alteration and destruction of the elements of the blood? or does it undergo chemical changes itself, and during these chemical changes generate from its own elements, and from those of the blood, substances capable of preventing and arresting the secretions of the organs, and of interfering with the nutrition and chemical actions of the muscular and nervous systems, and causing aberrated muscular and nervous actions? Are the acceleration and disturbance of the circulation and respiration, and the aberration of the nervous and muscular phenomena, due to

the direct action of the poison in the blood upon the muscular and nervous elements, or to the action of the altered constituents of the blood? Are the changes in the secretions of the liver due to the direct action of the poison upon the secretory structures, or to the action of the altered constituents of the blood supplied for secretion, or to the action of the poison of the altered constituents of the blood, upon that portion of the nervous system which influences the secretion of the liver?

In attempting to answer these questions, we can reason analogically, but not definitely and absolutely. The great difficulty is, that we have not as yet been able to isolate the poison. If we could isolate the poison, we would be able to watch its action, in combination with the actions of external agents, and compare its action with that of other known poisons upon the living system, under definite conditions. The relations of cause and effect could thus be determined, and the operation of the agents determined with a precision corresponding to the perfection of the modes of investigation.

If the physical and chemical properties of a poison be known, and if it can be isolated and weighed, a definite quantity may be introduced into the animal body, and by carefully-devised experiments the physiologist can determine the channels through which the poison is absorbed into the blood, and its effects upon the tissues with which it comes in contact, and its chemical and physical relations to the elements of the blood, and the influence of the changes produced by it in the elements of the blood, upon the organs and tissues, and upon the development and correlation of the physical, and vital, and nervous forces; and by carefully-devised experiments the physiologist can determine whether the action of the poison be confined to one or more organs, and whether the derangement of the chemical actions in these organs may not be the cause of the subsequent phenomena; and by careful analyses of the excretions of the kidneys, intestines, skin, and lungs, he can determine in what state the poison is thrown off; he can determine whether it has acted by its simple presence, or whether it has itself entered into the round of chemical change, and been either altered or destroyed; and by a comparison of the products of the metamorphoses of the elements of the living body with the alterations produced in the poison, and in the constituents of the blood, he can form some definite, if not absolutely correct idea of

the series of chemical changes leading to the alterations of the various secretions and excretions, and of the elements of the blood; and by carefully-devised experiments the physiologist and pathologist may also determine the relations of remedial agent to the poison. Upon the results of such experiments and investigations, a true, absolute system of pathology and therapeutics can alone be based.

It is evident that the perfect knowledge of all diseases will never be obtained, until the physician is able to isolate the special poisons, and determine their physical, chemical, physiological, and pathological relations. In the case of malarial fever, although analogical reasoning leaves no doubt in the mind that it is caused by the action of a special poison; still we are compelled to admit that up to the present time this poison has not only never been isolated, but that we possess no known tests for its presence, except the peculiar class of phenomena induced by it in the living organism. We are compelled to admit that as we cannot isolate, weigh, and experiment with the malarial poison, we cannot with certainty trace the channels of its introduction into the blood, neither can we follow it through the course of the circulation, and determine its physical, chemical, and physiological relations to the elements of the blood, and secretions, and organs, and muscular and nervous systems; nor can we tell the form and mode in which it is eliminated from the body.

Notwithstanding these imperfections of our knowledge, we can derive valuable information from the study of the symptoms, and of the changes of the blood, and secretions and excretions, and of the organs and apparatuses, and from a comparison of these with the analogous actions of those poisonous agents which can be isolated, weighed, and experimented with.

Color of the Blood and Serum in Malarial Fever.—In severe cases of malarial fever I have observed that the blood presents, when first abstracted, a dark purple almost black color, and after exposure to the atmosphere the change from the venous to the arterial hue upon the surface of the clot is always slower than in normal blood, and in very severe cases it changes to a cherry-red color, and not to the bright red assumed by the surface of healthy venous blood.

The blood found in the large veins after death always presented a deep purple and black color, and changed slowly to the arterial

hue upon the surface when exposed to the oxygen of the atmosphere.

The blood of the liver presented a dirty brownish red and purplish red color, which did not change to the arterial hue when exposed to the oxygen of the atmosphere. The relations of the coloring matter of the blood to the oxygen of the atmosphere were noted in sixteen malarial fever livers, and in each instance the result was the same—no change of color.

The blood of the enlarged, softened, slate-colored spleen of malarial fever, as far as my observations extend, presents reddish brown, and purplish brown, and purplish red colors, which remain unchanged during exposure to the oxygen of the atmosphere.

The serum during the active stages of the severest forms of malarial fever was always, whether obtained from the surface of blisters, or from the blood of the capillaries, or from that of the veins and arteries, during life or after death, of a bright golden yellow color. I have demonstrated in several cases that this coloring was due, in part at least, to the coloring matter of the bile. Whether this change in the color of the serum be entirely due to the presence of the coloring matters of the bile, or to the presence of the products resulting from the decomposition of the colored blood-corpuscles, or to the simple increase of the normal coloring matter of the serum, has not as yet been determined.

Specific Gravity of the Blood and Serum.—The specific gravities of both the blood and serum are diminished during the active stages of malarial fever, and during the slow action of the malarial poison. The following table will give a comparative view of the variation of the specific gravities of the blood in malarial fever and other diseases:—

Specific Gravities of the Blood and Serum in Various Diseases.

OBSERVERS.	DISEASES.	REMARKS.	Specific gravity of blood.	Specific gravity of serum.
Becquerel & Rodier	HEALTHY STANDARD	Established by the examination of the blood of 22 healthy persons	1055.0 to 1063.0	1027.0 to 1033.0
" "	" " . .	Mean in the healthy male . .	1060.0	1028.0
" "	" " . .	Mean in the healthy female . .	1057.0	1027.0
Nasse	" " . .	. . . .	1055 0	
Zimmerman . .	" " . .	. . . .	1056.0	
Joseph Jones . .	MALARIAL FEVER . .	Mean of 9 examinations of 9 men .	1038.3	1021.3
" . .	" " . .	Maxima of ditto	1042.4	1023.6
" . .	" " . .	Minima of ditto	1030.5	1018.0
" . .	" " . .	Seaman; intermittent fever of 12 d'ys	1042.0	1018.0
" . .	" " . .	Irish laborer; int. fever of 5 weeks	1034.0	
" . .	" " . .	Ditto, ditto of 6 weeks . . .	1030.5	1021.3
" . .	" " . .	Seaman; severe remit. fev. 16th day	1042.0	1022.5
" . .	" " . .	Ditto, ditto, 10th day . . .	1042.4	1021.3
" . .	" " . .	Remittent and typhoid fever, 11th d'y	1035.0	1021.0
" . .	" " . .	Remittent fever	1042.4	
" . .	" " . .	Intermittent terminating in congestive fever, 2 months . . .	1036.6	1023.6
" . .	" " . .	Congestive fever	1040.0	1022.0
Becquerel & Rodier	MARSH CACHEXY induced by MALARIAL POISON	Mean of 5 cases	1036.7	1021.2
" "	" "	Maxima of ditto	1040.5	1024.1
" "	" "	Minima of ditto	1033.8	1016.4
" "	TYPHOID FEVER . . .	Mean of 17 first bleedings . .	1054.1	1026.0
" "	" " . . .	Mean of 6 second bleedings . .	1051.4	1024.8
Guenaud de Mussy & M. Rodier	TYPHUS FEVER . . .	Mean of 6 cases	1047.9	1020.8
" "	" " . . .	Maxima of ditto	1055.5	1024.1
" "	" " . . .	Minima of ditto	1041.2	1020.0
Becquerel & Rodier	EPHEMERAL FEVER . .	Mean of 8 cases	1056.8	1025.5
" "	CHOLERA	In a man 30 years of age, bled on day of death	1074.1	1042.2
" "	ACUTE SCURVY . . .	Man 48 years of age, 6 weeks . .	1050.3	1025.5
" "	CHRONIC SCURVY . .	Man 32 years of age, 15 months .	1060.3	1026.2
" "	ANÆMIA	Mean of 10 cases of symptomatic anæmia	1049.9	1026.8
" "	CHLOROSIS	Mean of 6 cases, females . . .	1046.3	1026.1
" "	"	Maxima of ditto	1055 2	1032.2
" "	"	Minima of ditto	1035.2	1025.0
" "	ACUTE BRIGHT'S DISEASE	Mean of 15 cases	1048.2	1023.5
" "	CACHECTIC DROPSIES .	Mean of 16 cases	1039.6	1022.6
" "	PHLEGMASIÆ GENERALLY	. . . .	1055.4	1027.0
" "	ACUTE BRONCHITIS . .	. . . .	1056.7	1027.4
" "	PLEURISY	. . . .	1055.0	1026.0
" "	PNEUMONIA	. . . .	1052.6	1025.0
" "	ACUTE RHEUMATISM .	. . . .	1055.5	1025.0

As far as the observations (which are not only reliable, but present a condensed view of the most important results thus far recorded) presented in this table extend, they demonstrate that the specific gravity, or, in other words, the solid matters of the blood are more rapidly and decidedly diminished in malarial fever than in any other disease.

Coagulation of the Blood.—In severe cases of malarial fever I have always observed that the clot is voluminous, and much less consistent than the clot of normal blood, or of the blood of the phlegmasiæ, and that the contraction of the fibrin is much less, and as a

necessary consequence the amount of the serum forced out is much less than in normal and in inflammatory blood.

That the large size of the clot is due neither to an increase of globules, nor to an increase of fibrin, is conclusively demonstrated by the following tables:—

Table of the Blood-Corpuscles in 1000 *parts of Healthy and Malarial Blood.*

	Moist blood-corpuscles.	Water of moist blood-corpuscles.	Solid matters of moist blood-corpuscles.
The blood-corpuscles in healthy blood may vary from	480.000 to 600.000	360.000 to 450.000	120.000 to 150.000
Mean of 9 examinations of the blood of 9 cases of malarial fever	331.397	248.548	82.849
Maxima of ditto	431.508	323.631	107.320
Minima of ditto	207.948	155.861	51.812
Seaman; intermittent fever of 12 days	413.732	310.219	100.431
Irish laborer; intermittent fever of 5 weeks.	293.620	220.215	70.411
Ditto, ditto of 6 weeks	207.948	155.861	51.812
Seaman; severe remittent fever, 16th day	401.764	306.823	100.409
Ditto, ditto, 10th day	431.508	323.631	107.320
Remittent and typhoid fevers	262.448	196.836	62.703
Remittent fever terminating in congestive fever, 2 weeks	309.936	232.452	73 655
Congestive fever	317.748 343.872	238.217 258.804	76.000 84.400

Table of the Fibrin in 1000 *parts of Healthy and Diseased Blood.*

OBSERVERS.	DISEASES.	REMARKS.	
Andral & Gavarret Becquerel & Rodier	STANDARD OF HEALTH	In healthy blood the fibrin may vary from	2 000 to 3.500
Joseph Jones	MALARIAL FEVER	Mean of 9 cases of malarial fever	2.018
"	" "	Maximum of ditto	2.938
"	" "	Minimum of ditto	0.877
"	" "	Intermittent fever of 12 days	1.900
"	" "	Ditto of 5 weeks	2.540
"	" "	Ditto of 6 weeks	1.925
"	" "	Remittent fever of 16 days	2.938
"	" "	Ditto of 10 days	1.433
"	" "	Remittent and typhoid fevers of 11 days	2.380
"	" "	Remittent fever of 2 weeks	2.710
"	" "	Congestive fever	0.877
"	" "	Ditto	1.450
Becquerel & Rodier	MARSH CACHEXY induced by the MALARIAL POISON	Mean of 5 cases	3.390
" "	" "	Maximum of ditto	4.270
" "	" "	Minimum of ditto	2.360
Andral & Gavarret	TYPHOID FEVER	Mean of 41 analyses	2.600
" "	" "	Maximum of ditto	4.200
" "	" "	Minimum of ditto	0.900
M. H. Guenaud de Mussy & M. Rodier	TYPHUS FEVER	Mean of 6 cases	2.466
" "	" "	Maximum of ditto	3.900
" "	" "	Minimum of ditto	1.200
Andral & Gavarret	SMALLPOX	Mean of 5 cases	2 400
" "	"	Maximum of ditto	4.400
" "	"	Minimum of ditto	1.100
Becquerel & Rodier	EPHEMERAL FEVER	Mean of 8 cases	2.800
Andral & Gavarret	SCARLATINA	Mean of 4 cases	4 350
" "	"	Maximum of ditto	6.800
" "	"	Minimum of ditto	3.100
" "	MEASLES	Mean of 7 cases	2.742
" "	"	Maximum of ditto	3.400
" "	"	Minimum of ditto	2.400

Table of Fibrin in Blood—Continued.

OBSERVERS.	DISEASES.	REMARKS.	
Becquerel & Rodier	ACUTE SCURVY	Man aged 48 years, sick 42 days . .	2.500
" "	"	Man aged 21 years, sick 30 days . .	2.200
" "	CHRONIC SCURVY	Man aged 32, sick 455 days . . .	1.850
" "	"	Man aged 23, sick 552 days . . .	1.320
Popp	ERYSIPELAS	Man aged 33 years	6.600
Andral & Gavarret	"	Mean of 8 analyses	5.676
" "	"	Maximum of ditto	7.300
" "	"	Minimum of ditto	3.600
Wittstock . . .	CHOLERA	1 case	11.000
Simon.	"	Ditto	11.000
Becquerel & Rodier	. . . .	Man, day of death	1.880
" "	. . . .	Ditto	6.500
Andral & Gavarret	PHTHISIS	Mean of 21 cases	4.400
" "	"	Maximum of ditto	5.900
" "	"	Minimum of ditto	2.100
Becquerel & Rodier	"	Mean of 16 cases	4.800
Glover	SCROFULA	Mean of 8 cases, males	3 130
Heller	CARCINOMA	Mean of 7 cases	4.945
Becquerel & Rodier	BRIGHT'S DISEASE, ACUTE	Mean of 15 cases	2.990
" "	" "	Maximum of ditto	3.760
" "	" "	Minimum of ditto	1 650
" "	BRIGHT'S DISEASE, CHRONIC	Mean of 13 cases	4.340
" "	CHLOROSIS	Mean of 6 cases	4.200
" "	ANÆMIA	Mean of 10 cases	3 720
" "	"	Maximum of ditto	5.820
" "	"	Minimum of ditto	1 620
Andral & Gavarret	ACUTE RHEUMATISM . . .	Mean of 43 cases	6.700
" "	" " . . .	Maximum of ditto	10.200
" "	" " . . .	Minimum of ditto	2.800
" "	CHRONIC RHEUMATISM . .	Mean of 10 cases	3.800
Becquerel & Rodier	PUERPERAL FEVER . . .	Mean of 4 cases	6.760
Andral & Gavarret	PNEUMONIA	Mean of 58 analyses	7.300
" "	"	Maximum of ditto	10.500
" "	"	Minimum of ditto	4 000
" "	PLEURITIS	Mean	4.656
" "	. . . .	Maximum	5 900
" "	. . . .	Minimum	3.800
Becquerel & Rodier	. . . .	Mean of 5 cases	6.100
Andral & Gavarret	ANGINA TONSILLARIS . .	Mean of 6 cases	5.550
" "	" " . .	Maximum of ditto	7.200
" "	" " . .	Minimum of ditto	3.800
Becquerel & Rodier	ACUTE BRONCHITIS . . .	Mean of 4 cases	4.800
Andral & Gavarret	" " . . .	Maximum of 6 cases	9.300
" "	" " . . .	Minimum of ditto	5.700
Becquerel & Rodier	PHLEGMASIÆ GENERALLY .	Mean of numerous observations . .	5.800
" "	ACUTE BRONCHITIS . . .	Ditto, ditto	4.800
" "	PLEURISY	Ditto, ditto	6.100
" "	PNEUMONIA	Ditto, ditto, 1st bleeding . . .	7.400
" "	"	Ditto, ditto, 2d bleeding . . .	6.800
" "	ARTICULAR RHEUMATISM .	Ditto, ditto	5.800

This table demonstrates: first, that the fibrin is diminished greatly in severe cases of malarial fever; second, that the diminution of this element of the blood is characteristic not only of malarial fever, but of all fevers (Andral and Gavarret), whilst its increase, on the other hand, is characteristic of the phlegmasiæ (Hunter).

As a general rule, the diminution of the fibrin in malarial, as in the pyrexiæ generally, corresponds to the severity of the disease, provided there be no inflammatory complication.

As far as my observations extend, the diminution and alteration of the physical properties of the fibrin in malarial fever, to any great extent, was always accompanied by congestions of the spleen,

liver, and brain, and serious cerebral disturbances. Whether these phenomena stand in the relation of cause and effect, cannot be determined simply by their association in a single disease, or in a class of diseases, independent of an investigation of the offices and relations of fibrin in health and in disease.

These facts, with reference to the decrease of fibrin in malarial fever, are invested with interest and importance, in their agreement with the results of the investigations of Andral and Gavarret, and Becquerel and Rodier, in the changes of the blood in typhoid fever, and of Guenaud de Mussy and Rodier, in typhus fever.

The fibrin is not only diminished in malarial fever, but it is altered in its properties and in its relations to the other elements of the blood, and to the bloodvessels.

We will illustrate this proposition by the following cases and *post-mortem* examinations:—

Case illustrating the Physical Changes of the Fibrin, and the Formation of Heart-Clots in Malarial Fever.

Irishman—age 26; height 5 feet 11 inches; weight 170 pounds; black hair; black eyes; full, dark-brown beard and mustache. Limbs full and round, chest broad, and well developed. Has been in America (New York) nine years, and in Savannah three months. During this time he has followed the occupation of a baker.

Sept. 11, 12 o'clock M., 1857. Has just entered the Savannah hospital with remittent fever. Pulse accelerated but feeble, and his complexion shows the effects of malarial fever. Says that he has been sick for one week, and has been living near the depot of the Albany and Gulf Railroad, in a low, malarious situation. Under the action of sulphate of quinia and stimulants, the febrile excitement disappeared in the course of four days; the patient, however, was left in a very feeble condition; complained of great weakness, his pulse was feeble, the action of the intellect sluggish, and he had a peculiarly disagreeable smell, which was not permanently removed, either by water or by a change of clothing.

Under the action of tonics, he recovered sufficiently to walk about the yard; but continued, however, weak, low-spirited, and indisposed to action.

27th. Complained of torpor of the bowels. A mild cathartic was administered.

28th. Has a cough. The wind has been from the northeast for

some time, and the weather has been cold and damp, and epidemic catarrh is prevailing. About two-thirds of the hundred patients now in the hospital are suffering with the influenza.

This patient was up and about the wards, assisting and nursing the patients all day. He was up and about when I went the rounds of the wards at 9 o'clock P. M. Shortly after this he complained of great oppression of the lungs, difficulty of breathing, and loss of muscular power.

29th, 9 o'clock A. M. During the night took a sudden and remarkable change for the worse.

Respiration spasmodic, and sounds as if the air-cells, bronchial tubes and trachea contained large quantities of fluid, and is attended with a loud rattling sound in the throat. The churning, rattling, gurgling, crackling sounds of the lungs and trachea are very loud, and can be distinctly heard over the upper wards of the hospital. Muscular power completely exhausted; lies upon his back, and is unable to turn upon either side. Surface of extremities cold; surface of trunk cool, several degrees below the normal standard. The temperature of the extremities does not differ essentially from that of the surrounding medium. The expression of his eyes and countenance, and his efforts to converse, show that he is intelligent; he is, however, entirely unable to articulate or expectorate.

Sinapisms were applied to the extremities, epigastric region and chest, and stimulants were administered freely. These did not produce any beneficial effects—did not arouse the circulation, and did not increase the animal temperature, because the supply of oxygen necessary for the chemical changes which generated the physical, muscular, and nervous forces, was cut off. The mustards scarcely reddened the skin, even after the application of several hours.

The patient continued in this state, with a gradual diminution of power, until 1 o'clock A. M. the next morning, when the painful respiratory sounds were hushed in death.

AUTOPSY EIGHT HOURS AFTER DEATH.

Exterior.—Body in good condition, not emaciated; limbs full and round; muscles of trunk and extremities covered by a thick layer of fat; face and hands sallow and sunburnt; surface of the skin which had been covered by the clothes, fair.

Head.—Dura mater presented the usual appearance. Arachnoid

membrane transparent and healthy, bloodvessels of pia mater filled with blood.

When the dura mater was removed, an ulcer in the substance of the brain was discovered, occupying a position near the centre of the superior surface of the left hemisphere of the cerebrum. This ulcer was three-fourths of an inch in length, half an inch in breadth, and one-eighth of an inch in depth. The walls were thickened and much harder than the surrounding brain. The bloodvessels of the surrounding pia mater and brain were congested with blood, and a small quantity of bloody serum was effused between the arachnoid and pia mater in the immediate neighborhood of the ulcer, but nowhere else. The appearance of the ulcer, and the congestion of the bloodvessels around, by no means accounted for the death of the patient. The thickened walls, the absence of pus, and the sound state of the structures of the brain around, show not only that the ulcer was of long standing, but also that it was rapidly healing. The existence of this ulcer will account, in part, for the dull, lethargic state of the intellectual faculties, but not for the death of the patient.

The ventricles of the brain contained a small quantity of clear serum.

The structures of the brain presented the usual consistence and appearance.

Chest.—Heart normal in size; the right ventricle contained a large light yellow fibrinous clot, attached to the chordæ tendineæ and carneæ columnæ, and extended through the auriculo-ventricular opening into the auricle. This clot was firm in texture, and weighed one ounce. The left ventricle contained a small light yellow clot; the aorta also contained a small, flattened, ribbon-like, light yellow clot. *These clots were evidently formed previous to death, when the circulation was exceedingly feeble.*

Lungs.—The lungs were greatly inflated, and did not collapse in the slightest degree when air was admitted into the pleura. They were congested with blood, and resembled in appearance liver; and when handled they were remarkably heavy, and felt more like liver than lungs. When cut, the air-cells, and large and small bronchial tubes, were found filled with serous fluid, and numerous fine bubbles of air. When the lungs were squeezed, pints of this serous fluid flowed out. In many portions of the lungs the serous fluid was clear; in others it was reddish. The fluid resembled serum in all respects, and was not mucus. Here, then, we have the cause of the death of this patient. He was drowned.

Abdominal Cavity.—Stomach pale and perfectly healthy in appearance; *intestinal canal*, from the stomach to the anus, pale and healthy in appearance.

Liver.—The normal reddish-brown color of the liver was changed in most parts to a mixture of light bronze and light olive, and in several places resembled the normal color. In two circular spots, about three inches in diameter, the liver was of a dark-bluish slate color, like that of a recent case of malarial fever. The cut surface of the liver approached more nearly to the normal color than the exterior. The blood of the liver, after exposure to the atmosphere, assumed a red arterial color. It is evident from this examination that the structures of the liver were recovering from the effects of the malarial fever, and that the organ was regaining its normal color.

Spleen.—Slate-colored, enlarged, and softened. The pulp of the spleen presented a dark purplish-brown color, which did not change to the red arterial color as rapidly as the pulp of healthy spleens; the change of color, however, was much greater than that of the pulp of the spleen in recent cases of malarial fever. This organ, like the liver, appeared to be recovering from the effects of malarial fever.

Kidneys.—Healthy.

We believe that we have now all the facts necessary for a rational explanation of the phenomena presented by this case.

The malarious poison and its effects had produced profound alterations in the blood and capillaries, liver and spleen, and primarily by its direct action, or secondarily by the action of the altered products in the blood, affected the sympathetic and cerebro-spinal nervous systems. The patient, although weak and lethargic on account of these pathological alterations and the ulcer upon the brain, was, nevertheless, in a fair way of recovery; the alimentary canal had resumed its healthy actions, and the liver and spleen were fast recovering, and he was gaining strength daily. We can, in view of these facts, safely assert that if no other disease had occurred, the lesion of the left hemisphere of the brain, and the effects of the malarial poison, would not have proved fatal.

In this state of slow convalescence the patient was suddenly seized with the prevailing influenza. The mucous membrane of the bronchial tubes and air-cells was irritated. The irritation of the mucous membrane was followed by congestion of the blood-vessels and capillaries of the lungs. The capillaries were in an

enfeebled state; the fibrin of the blood was diminished in quantity, and altered in physical and chemical properties; the colored blood-corpuscles were diminished in number, and physically and chemically altered; the solid matters of the blood were diminished; and the physical and chemical relations between the individual constituents of the blood and the capillaries were disturbed. Healthy limited inflammation was impossible. Diffused inflammation of all the structures of the lungs resulted; the serous portion of the blood poured into the air-cells, bronchial tubes, and trachea; the supply of oxygen was in a great measure cut off; the chemical changes of the solids and fluids in a corresponding degree checked; the physical forces, heat and electricity, and the nervous force, developed by these chemical changes, were, as a necessary consequence, correspondingly diminished.

The immediate cause of the death of this patient was a deprivation of oxygen and the retention of the carbonic acid gas. We may say with truth that he was drowned.

Case illustrating the Changes of the Fibrin, and the Formation of Heart-Clots in Malarial Fever.

Irishman—laborer and boatman; age 30; height 6 feet; weight 150 lbs.; tall, spare frame, light hair, blue eyes; pale, sallow complexion. Has been running on flatboats and rafts, up and down the Savannah River, between Savannah and Augusta, for the last twelve months. Habits irregular; addicted to the use of ardent spirits. Says that his constitution has suffered much from the exposure to the hot sun and night air on the river, and also from the intemperate use of ardent spirits.

September 20, 1857. "A flat, laden with wood, which he was bringing to the city, was sunk in shoal water." He was all day in the water, up to his waist, fishing out the wood; and at night had a chill, followed by fever. The fever went off before morning, and on the next day he was employed again in the water. The chill returned at night, and was followed by high fever. Has been sick from this time to the present time, September 27th, without any medical attendance.

Pulse 106; respiration accelerated, labored; skin hot and dry; countenance distressed; has a haggard, anxious look; complains of great thirst, of pains in his back and bones, and of great exhaustion. His pulse, although rapid, is feeble, and his forces appear to

be completely exhausted. His fever remitted slightly on the next day, but returned on the 29th inst. Under the action of large doses of sulphate of quinia, and stimulants, sinapisms, snakeroot-tea, and milk-punch, and wine-whey, and brandy and arrowroot, the febrile excitement subsided, the urine regained its normal hue, and on the 4th inst. his pulse was 70, and respiration 18; temperature normal, and function of skin normal; and although apparently very weak, the patient was able to be up and about the ward.

During this attack the saliva was acid, and the urine copious; from 20,000 to 25,000 grains were excreted daily. The specific gravity was correspondingly low, from 1012 to 1014. The abundant discharge of urine was due to the large quantities of water which his thirst led him to take, and also to the diuretic action of the infusion of snakeroot. Throughout the attack his pulse was feeble and his forces greatly exhausted, and he required close attention, and the free administration of stimulants.

October 5th. This morning escaped clandestinely from the hospital.

8th. Has returned. Pulse 120; skin hot and dry; respiration accelerated, labored; complains of great pain in the back of his head and neck; these parts are swollen, and painful upon pressure. ℞.—Cold water dressing to back of head and neck.

9th. His head has been shaved, and the tissues above the occipital bone, and above the left temporal and parietal bones, are swollen, and the skin looks black, and is ulcerated in several places. The swelling extends down along the neck, and reaches the superior portion of the left shoulder. To the finger the swollen parts feel as if there was a collection of fluid beneath the skin. Says that he is suffering intense pain; countenance distressed and haggard; pulse 128; skin hot and dry; respiration thoracic, labored, accelerated.

10th. Pulse 160, feeble; skin hot; respiration spasmodic and labored. In addition to the intense pain in the back of his neck and left side of the head, he complains of intense pain in his chest. The pain in the chest cuts short the respiration, and renders it spasmodic. His countenance is expressive of great agony and terror.

11th. Pulse 140, rapid and very feeble; respiration 24, labored, thoracic, spasmodic. The pain in his chest is intense; he groans and cries at every breath, and the expression of his countenance is indicative of great agony, terror, and horror. Was restless and

delirious during the night, and during his delirious visions spoke and acted as if he was engaged in mortal combat. Has no hope of himself, and refuses all medicine. The back of his neck and side of head is much swollen, and when pressed with the hand there is a distinct fluctuation. Hoping that discharge of the pus, or fluid, would afford relief, a free crucial incision was made at the most prominent part of the swelling. Nothing but blood issued. The hemorrhage was so great, that it was necessary to check it by the application to the wound of a compress, saturated with the tincture of muriate of iron.

12th. During the night was delirious; would rip out the most terrible oaths, and cry out that the devils were after him, had beaten him severely, and were endeavoring to throw him out of the windows. At other times he would speak and act as if he had been in mortal combat, and was wreaking vengeance upon an imaginary antagonist. These actions excited the suspicion that the injury on the back and side of the head was received from a blow.

The patient died at one o'clock A. M. this morning.

AUTOPSY NINE HOURS AFTER DEATH.

Exterior.—Body much emaciated; back and left side of neck much swollen. The inferior surface of the trunk and neck presented a mottled appearance, from the settling of the blood by gravitation during the last hours, when the circulation was feeble. On the right leg there were the marks of an extensive ulcer upon the skin covering the tibia; the cicatrix presented a purplish, angry color. When incisions were made into the swollen parts of his neck, and back and side of head, the spaces between the muscles, the meshes of the fibrous tissue surrounding and connecting together the muscles and the fibrous tissue of the skin, were found to be completely filled and distended with golden-colored serum.

Head.—*Dura mater* healthy. *Arachnoid membrane* transparent throughout its entire extent over the hemispheres of the brain. At the base of the brain it was slightly opalescent.

Bloodvessels of *pia mater* not more filled with blood than usual.

The cortical and medullary substances of the cerebrum, and of the cerebellum, and the structures of the pons Varolii, the medulla oblongata, and superior portion of the spinal marrow, appeared natural in consistence and color.

Ventricles of brain contained f℥iv of golden colored serum.

The superior longitudinal sinus of the dura mater contained a golden-yellow elongated clot, the diameter of which was about one half that of the longitudinal sinus.

Chest.—Heart somewhat enlarged. *Pericardium* contained f℥j of golden serum. All the cavities of the heart contained golden-colored clots. The right auricle had a large golden-colored clot, which was attached to the carneæ columnæ and chordæ tendineæ of the auriculo-ventricular valves. The aorta, carotids, and pulmonary arteries contained elongated golden-colored clots, having diameters nearly equal to those of the arteries. All these clots were firm and elastic.

Lungs.—The lungs did not collapse when the cavity of the chest was opened. Exterior surface of the pleura covering the lungs and lining the walls of the thorax was covered with soft coagulable lymph of a golden-yellow color. Adhesions were numerous, but as yet not strong, on account of the soft, fresh condition of the coagulable lymph, which was evidently but recently effused, probably within the last seventy hours. This inflammation of the pleura accounts for the severe pain in the chest during life. The lungs were much congested with blood, and when cut they resembled liver. The bronchial tubes and air-cells contained much serum. This serous fluid poured in large quantities from the cut surface.

The anterior surface of the middle lobule of the right lung had a dark blackish-red spot, about one inch in diameter, which resembled at first sight a wound from a sharp instrument. An examination of the exterior of the chest, and interior surface of the ribs, showed neither wound nor fracture of the ribs. When closely examined, this portion of the lung was found to be more congested and solidified than the surrounding portions, and would in all probability, if the patient had survived, been the seat of an abscess.

Abdominal Cavity. Alimentary Canal.—The stomach, although enormously distended with gas, was pale and healthy in appearance; small intestines also pale and healthy, to the naked eye.

Liver of a light bronze color. The color is lighter than that of the liver in the active stages of malarial fever, but resembles the color of a liver which was recovering from the effects of malarial fever. Cut surface of a light bronze color, and not of such a deep and decided bronze as the liver of the active stages of malarial fever. The right lobe of the liver had upon its under surface a slate-colored spot three inches in diameter, which resembled in all

respects the liver of a recent case. When an incision was made across this spot, the cut surface presented for one-sixth of an inch the true malarial hue; below this it approached more nearly the normal hue. The structures of the liver did not appear to be softened.

Spleen.—Much enlarged, of a dark-slate color, and although much softer than a normal spleen, it was much harder than a spleen of a recent case of malarial fever. Weight 31 ounces. This organ, like the liver, appeared to be just recovering from the effects of malarial fever. Kidneys appeared to be somewhat enlarged; the calices, infundibula and pelvis of the kidney contained a fluid resembling pus.

The following appears to be the cause and history of this last attack:—

The patient left the hospital when he was in an exceedingly feeble condition, after a severe attack of remittent fever. It is probable that he indulged his taste for ardent spirits, for the day on which he left the hospital was election day. The wind was from the northeast, and the weather damp and cool, with occasional scuds of rain and mist. Exposure to this cool damp wind, fresh from the ocean, and the low grounds and swamps of Georgia and South Carolina, not only during the day but probably during the night also, in a state of intoxication, induced a severe attack of pleuro-pneumonia.

The swelling on the back of his head was due either to a blow or to inflammation in the cellular tissue and muscles analogous to the inflammation of the lungs, and probably arising from the same cause.

The large amount of serum effused into the bronchial tubes—the large amount of golden-colored serum effused into the cellular tissue of the neck and head—and the large golden, fibrous clots in the heart and arteries—the settling of the blood in the most dependent parts of the body—the appearance of the cicatrix, and the inflamed spot in the lungs, all indicated disturbances in the constitution of the fibrin, and of the relations between this element and the other elements of the blood to each other, and to the bloodvessels and capillaries.

The occurrence of the fibrous clots in the heart and bloodvessels during malarial fever, demands a careful investigation.

As far as my observations extend, the formation of heart-clots during life is very common in malarial fever.

In fifteen *post-mortem* examinations I found heart-clots in ten

cases, and of the remaining five, one was a case of typhoid fever combined with remittent fever, another was a case of malarial fever of long standing, where the patient died of exhaustion, and in the remaining three no special examination for heart-clots was instituted. The following cases, in addition to the two just reported, will illustrate the symptoms attending the formation and existence of these heart-clots:—

Fatal Case of Congestive Fever, terminating suddenly—Fibrinous Concretions in the Heart and Pulmonary Bloodvessels, and Aorta.

Irish laborer; height 5 feet 10 inches, weight 150 pounds; black hair, black eyes, dark complexion, resembles an Arab in appearance; person, dirty and filthy.

Sept. 2d, 1857, 12 o'clock M. Has been sick, on the bay, for ten days, with an abscess in the palm of his hand; previous to this he had been working on the river bank.

When first brought (this morning) into the hospital, he appeared stupid, and urinated in the bed. After the administration of a hot bath, and the lancing of his hand, he was aroused, and now appears to be entirely restored to the exercise of his intellect. Seems to be very weak, and complains of no pain, or trouble anywhere, except in the palm of his hand. Skin not warmer than usual; tongue dry, red, and glazed, and harsh and rough to the touch; pulse 82.

Continued sensible, and apparently convalescent, and complained of nothing, and manifested no striking phenomena until Sept. 3d, 3½ o'clock P. M.

At this hour I was summoned hastily, and found this patient insensible, with his mouth open and groaning loudly at every breath. His groans sounded very much like the barking of a dog. Countenance distressed, anxious, and expressive of great agony; tendons twitching violently; teeth coated with sordes; tongue dry, red and glazed, and harsh to the feeling. Respiration 40, thoracic, panting; pulse 104. Temperature of hand 103° F. Skin hot, dry, and rough. When the attempt is made to arouse him, by violent shaking and loud talking, he mutters incoherently. Great tenderness upon pressure of epigastrium; cries out whenever this region is pressed. Cups to the temples and back of neck, a large blister over the epigastric region—sinapisms to the extremities, stimu-

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lants and sulphate of quinia, all failed to arouse this patient, and he died twenty hours after this observation.

There was but little change in the symptoms, with the exception of an increase in the frequency of the respiration and pulse.

AUTOPSY THREE HOURS AFTER DEATH.

Head.—When the skull-cap was removed, the dura mater presented the usual appearance. Serous effusion had taken place between the dura mater and membranes, and surface of the brain. f℥iij of bloody serum flowed from the base of the brain, and there had been an effusion of golden-colored serum between the arachnoid and pia mater. Bloodvessels of pia mater filled with blood. Bloodvessels at the base of the brain, and upon the medulla oblongata and spinal cord, more engorged with blood than those upon the superior portions of the brain. This was, without doubt, due solely to the effect of gravity. The substance of the brain possessed the usual consistency, and appeared to the naked eye to be normal in structure.

Chest.—*Lungs* normal; trachea filled with froth.

Heart, normal. The right auricle contained a large golden-colored clot, which filled almost the entire cavity. The left auricle contained several small yellow clots.

The right ventricle contained several small clots of blood, which resembled, in all respects, coagulated blood.

The main trunk of the pulmonary arteries contained a long, flattened, ribbon-like, yellow clot, which extended not only through the large trunk, but divided and sent off branches to each branch of the pulmonary artery; and then again subdivided and sent branches off to the minor branches of the arteries. When the main clot in the pulmonary artery was gently pulled, the branches were drawn out twelve inches in length, and at their extremities were not much larger than a fine silk thread. The clot was almost entirely free from red corpuscles, of a yellow color, firm, and elastic in structure, and in appearance resembled an organized product.

A similar ribbon-like, yellow, elastic clot, extended through the whole length of the aorta. The blood in the vena cava was coagulated, but the coagulum was like that of ordinary blood, and much less firm than the clots of the right auricle, pulmonary arteries, and aorta.

Abdominal Cavity.—The *liver* presented the true malarial hue; contained no grape sugar, but an abundance of hepatic starch; and

its blood did not change to the arterial hue when exposed to the atmosphere. The spleen was enlarged, softened, and of the slate-color of malarial fever.

Stomach, *intestines* and *kidneys* normal.

The autopsy demonstrated this to be a case of malarial fever.

Case of Congestive Fever illustrating the Formation of Fibrinous Coagula in the Heart and Bloodvessels.

Irish seaman, aged 24; light hair, light blue eyes, fair complexion; height 5 feet 7 inches; stout, well built, weight 150 pounds.

Oct. 12th, 1857, 12 o'clock M. Entered the hospital two hours ago. Now, he is out of his head, and can give no history of his case. A companion states that he has been watching at night on board a brig, lying in the river, below the ship-yard, along the low marshy shore of the Savannah River, and that he was taken sick with chill and fever one week ago, but did not, until two nights ago, discontinue watching at night. Habits intemperate.

Pulse 137, rapid and feeble; respiration 32; skin, hot and dry. Tip of tongue clean, and of a bright red color—the remaining portion of the tongue is coated with yellow fur. The tongue is dry and harsh to the touch, and feels, when the fingers are passed over it, like sand-paper. The patient mutters to himself continually, half-formed sentences and imperfect words. Continues to mutter in the same incoherent manner, notwithstanding strenuous efforts to arouse and attract his attention. About one hour ago his extremities felt cooler, and his pulse was more feeble than it is now; mustards were applied to the extremities—they increased the temperature and rendered the pulse somewhat fuller, and aroused his intellect for a moment, but he again relapsed into the state of delirium.

Mustards to the epigastrium and extremities, cut cups to the temples and back of neck, stimulants and sulphate of quinia and purgatives, failed to arouse the intellect, and at 8 o'clock P. M., the patient lay in a profound stupor, with full rapid respiration and full rapid pulse. Pulse 124, and has increased in force and volume under the action of the stimulants and sulphate of quinia. Skin hot and dry; tongue presents the same dry and rough appearance. ℞.—Continue the stimulants and sulphate of quinia, and apply blisters to the back of the neck and over epigastric region.

13th, 11 o'clock A. M. The cut cups to the head, the sinapisms

upon the extremities, the blisters upon the back of the neck and epigastric region, and the diffusible stimulants and cathartic have failed to arouse this patient, and he now lies in a comatose state, and passes his urine and feces in the bed. The nurse states that during the night, he was much more restless than at the present time, and it was necessary to give constant attention that he did not fall out of the bed. The medicine has operated freely, and the blister has drawn well. The serum from the blistered surface is of a golden color.

Respiration 30, stertorous. The patient lies in a stupor, with his eyes shut and mouth open, and emits a suppressed groan, or whine, at every breath—his appearance, and the sounds which he emits, are similar to those of the patient described in the preceding case. These groans appear to be entirely involuntary, and depend upon the state of the organ of voice, and the mode in which the air passes through it.

Pulse 144, feeble. The sounds of the heart cannot be distinguished—they are both united into one, and the heart makes a short, quick, thumping sound. The number of the thumps of the heart corresponds to the pulse, 144 to the minute. Temperature of atmosphere 77° F.; temperature of hand 103°.5, temperature in axilla 104°.5. Skin hot and dry; teeth coated with sordes. Cannot get a sight of his tongue, as his teeth are tightly closed, and he is entirely insensible.

I have just applied mustards to his extremities—they do not arouse him—after remaining on one hour they scarcely redden the surface.

9 P.M. Profound coma; respiration thirty-two, spasmodic; pulse is gone; heart merely flutters; head and trunk warm, extremities cold. Have again applied mustards to the extremities, and administered diffusible stimulants, but they do not produce the slightest effect, and he will die in the course of one hour.

The patient died half an hour after this observation.

AUTOPSY TWELVE HOURS AFTER DEATH.

Body in good condition, apparently not at all reduced; limbs full and round, muscular, well developed; complexion fair, with a slight tinge of yellow; skin of the dependent portions slightly darker than that of the superior portions of the body; rigor mortis remarkably strong; it required all the force that I could exert to straighten his arms, and they would return back to the bent posi-

tion with considerable force; after the right arm had been straightened out at right angles to the body, and while I was standing between the arm and the body, engaged in opening his abdomen and thorax, I felt the pressure of a hand and arm upon my back—this was the hand of the dead man, which had slowly returned to its former position by the contraction of the muscles.

Head.—Dura mater normal in appearance; *the longitudinal sinus of the dura mater contained an elongated, flattened, ribbon-like, fibrinous clot, which was free from colored blood-corpuscles, and of a yellow color. This, without doubt, was formed before death. Arachnoid membrane* opalescent, pearl colored in many places; bloodvessels of pia mater filled with blood. The substance of the brain appeared to be normal in color and texture, as far as an examination with the naked eye extended; it was perhaps a little softer than usual, but this may have been due to post-mortem changes, and at any rate would not account for the symptoms during life; ventricles of the brain contained no serum; bloodvessels of medulla oblongata and superior portions of spinal cord not congested with blood.

Chest.—Exterior surface of the heart adherent at all points to the pericardium. There was no free space between the heart and the pericardium, hence no fluid lubricated the heart. If this lesion was the result of inflammation, it is certain that the inflammation had nothing whatever to do with the present attack of fever. Muscles of the heart paler than usual. *The right auricle and ventricle contained a yellow clot, free from colored blood-corpuscles, which was attached to the columnæ carneæ, and chordæ tendineæ of the right ventricle, and extended through the auriculo-ventricular opening into the auricle. This clot sent off a large branch into the pulmonary artery. This branch of the yellow fibrinous clot, which almost completely filled up the pulmonary artery, subdivided and sent branches down the right and left pulmonary arteries, and these branches again divided and subdivided into numerous branches, the smallest of which were not larger than fine threads. These fibrinous threads passed deep into the bloodvessels of the lungs, probably almost to the commencement of the capillaries. The left ventricle contained a similar yellow fibrinous formation almost entirely free from colored blood-corpuscles, which was attached at one extremity to the columnæ carneæ, and chordæ tendineæ, and extending through the auriculo-ventricular opening into the auricle, subdivided into branches, which passed up the pulmonary veins, and subdivided into numerous smaller branches which occupied the smaller divisions of the pulmonary veins. These fibrinous bodies of the pulmonary veins*

and arteries were very elastic—with care they could be drawn out of the smaller branches of the pulmonary veins and arteries, four and six inches in length, without breaking, notwithstanding that the smallest branches were very delicate. The aorta contained a similar clot. All these clots were of a bright yellow color, almost entirely free from colored blood-corpuscles, and presented almost an organized appearance, and were, without doubt, formed long before death.

The large nervous trunks were distended with partially coagulated black blood; the heart, arteries, and pulmonary veins contained little or no blood.

When the black blood from the large venous trunks was exposed to the atmosphere, it assumed slowly and imperfectly the arterial hue. The blood appeared to have been collected in the capillaries and veins. If the chemical changes between the colored blood-corpuscles and liquor sanguinis, and between the blood-corpuscles and the capillaries, and the structures and fluids surrounding the capillaries, be arrested, as a necessary consequence the circulation of the colored blood-corpuscles through the capillaries must be greatly interfered with.

Lungs.—Normal in appearance and structure; lower (dependent) portions congested with blood. This was due to the action of gravitation. The trachea, bronchial tubes, and air-cells contained much froth.

Abdominal Cavity.—The mucous membrane of the stomach presented to the naked eye no marks of inflammation or pathological alteration.

The mucous membrane of the small intestines presented a darker color, the bloodvessels appeared to be more congested with blood than usual, but there were no marks of inflammation, and the congested state of the vessels appeared to be entirely due to the action of the cathartic.

Liver.—The liver presented a much darker color upon its exterior than normal, but not the dark slate color of cases of malarial fever of longer standing. When incisions were made into the liver, the cut surface was different in appearance from that of the healthy liver, and approached the bronze color of malarial fever. The color of the cut surface, however, was several shades lighter than that of malarial fever of longer standing. On the under surface of the right lobe were several spots of the dark slate color peculiar to malarial fever. The liver-cells presented the usual appearance.

In some cases they, as well as the tissues around, appeared to contain more oil-globules than usual.

The liver contained animal starch without a trace of grape sugar.

Spleen enlarged, softened, disorganized, and of a dark slate malarial color; when pressed gently between the fingers, the trabeculæ could be felt giving way. After eight hours' exposure to the atmosphere, small streaks, inclining to an arterial hue, appeared upon the cut surface of the spleen, and probably were due to the change in the blood which issued from the divided vessels.

The dark effused blood of the spleen was found under the microscope to consist of colored and colorless corpuscles and dark granules; some of the colored corpuscles were swollen, and altered in shape. The alteration was by no means universal or remarkably great.

Kidneys.—This subject had but one kidney; this corresponded to the right kidney. The inferior surface of the kidney presented a dark slate-colored spot, two inches in diameter; the color of the spot resembled in all respects the slate color of the malarial fever liver. When an incision was made into the substance of the kidney, through this slate-colored spot, the cut surface presented a bronze color to the depth of about one-sixth of an inch. The bronze color gradually shaded into the normal color of the kidney. With the exception of this slate-colored spot, the color of the kidney was normal.

After a careful examination of the symptoms and the pathological alterations presented by these two cases of congestive fever, it appears that, with the exception of the heart-clots, we do not discover any pathological changes of the cerebro-spinal nervous system, and of the organs, which of themselves would account for the sudden severity of the symptoms, or the death of the patient.

As far as an examination with the eye extended, we did not discover in the brain any structural alterations sufficient to account for the sudden and alarming symptoms of delirium and coma. We should not, however, in the present state of chemical, physiological, and pathological science, decide dogmatically a question of such importance, for we are wholly ignorant of the chemical, physiological, and pathological relations of the malarial poison to the nervous elements. It is evident that a thorough knowledge of the phenomena of malarial fever demands, amongst many other things, a thorough knowledge not only of the appearance and chemical constitution of the structures of the cerebro-spinal and sympathetic

nervous systems, but also a thorough knowledge of the physical, chemical, and pathological alterations of these structures, when acted on by morbific agents.

Whatever were the alterations of the nervous elements in this case, it was evident that they could not be reached by the most energetic and vigorous treatment. It was impossible to arouse the action of the brain, notwithstanding that there was no inflammation, and only that congestion of the blood in the capillaries which resulted from the feeble action of the circulatory apparatus, the disturbance of the relations of the blood and capillaries, and the alterations of the constituents of the blood.

We do not think that the condition of the spleen in these cases was sufficient to cause death, because we have seen cases where sudden death occurred from other diseases during convalescence from malarial fever, in which the spleen was apparently in a worse condition.

The same remark applies to the alterations of the liver; as far as our examination extended, they do not appear to have been sufficient to cause death.

The stomach and intestinal canal presented no special pathological alterations. The slate-colored spot upon the kidney was interesting, especially in its bearing upon a similar change in the color of the liver, but it was not sufficient to account for even one of the symptoms.

Can we, then, from this analysis of the pathological phenomena, infer that the immediate cause of death did not exist in the pathological alterations of the organs and tissues, but in the disturbances of the general and capillary circulation, and especially of the function of the lungs, by the fibrinous coagula in the cavities of the heart and in the bloodvessels.

It is important that we should, before deciding this question, consider the occurrence of these coagula in other diseases, and the attendant phenomena.

Various opinions have prevailed with reference to the fibrous concretions found in the heart and bloodvessels after death, and almost up to the present time a dispute has been carried on concerning the time of their formation, some contending that they were formed during life, and others that they were formed after death. Apart from the evidence afforded by the lamellated structure of these bodies, their freedom from colored blood-corpuscles, and the absence of colored blood in the surrounding cavities of the

heart and bloodvessels, we find scattered through the records of medicine numerous facts, established by independent observers, demonstrating in the clearest manner the formation of these concretions before death.

Hewson[1] found in the right ventricle of the heart of a dog, which had been killed eight hours after receiving a large wound in his neck (the wound had during this time inflamed considerably), a large whitish polypus, under which was a little blood, still fluid, which coagulated after exposure to the air.

Baillie,[2] Morgagni,[3] and Albinus[4] have described the obliteration of veins by the formation of coagula during life. Mr. A. Burns[5] found in the right auricle of a human heart a large, dense, lamellated polypus (fibrinous concretion), which was so firmly attached to the rough surface of the musculi pectinati as to allow the whole mass of the heart, and a considerable portion of the lungs, to be suspended by it. Mr. J. Stewart[6] has described a heart which contained fibrinous concretions in the right auricle and in both ventricles. Mr. Burns reports a case in which a polypus more than one inch long was attached so firmly to the septum of the heart that the ventricle was torn before the polypus could be torn from its attachment. He also affirms that in the centre of this polypus an abscess was found which discharged a teaspoonful of perfectly formed purulent matter.

Wardrop[7] and Cruwell[8] have recorded similar phenomena.

Graham,[9] Stenzel,[10] Meckel,[11] Stoerk,[12] and others, have described laminated fibrinous coagula in the aorta, and Baillie[13] found two coagula, laminated like the walls of the sac of an aneurism, firmly attached to the inside of the carotid arteries.

M. Petit and O'Halloran have observed that the bloodvessels

[1] An Experimental Inquiry into the Properties of the Blood. By William Hewson. London, 1771. P. 49.

[2] Trans. of A. Soc., vol. i. p. 129.

[3] Annot. Academ., lib. 7, c. 2.

[4] Epist. 36, art. 10. Op. Path., p. 6, sec. 8.

[5] Diseases of the Heart, p. 197.

[6] Edinb. Med. and Surg. Journ., for 1817.

[7] Baillie's Works, vol. ii. p. 20. A. Burns on the Diseases of the Heart.

[8] De Cordis et Vasorum Osteogenesi in Quatrogenario Observata. Halæ, 1765.

[9] Med.-Chir. Transactions, vol. v. p. 297.

[10] Dissertatio de Steatomatibus Aortæ.

[11] Mém. de l'Acad. R. de Berlin, 1756.

[12] Med.-Chir. Transactions, vol. v. p. 287.

[13] Transactions of the Society for the Improvement of Medical and Surgical Knowledge, vol. i. p. 191.

immediately above, and in sphacelated parts, are filled with fibrous concretions.

Mr. Martial,[1] in 1694, in amputating the legs of a poor woman affected with gangrene, found that no hemorrhage followed the amputation of the first leg, and that in like manner no hemorrhage would have followed the amputation of the second leg, had not the surgeon, after cutting off the limb, pulled out from the extremity of the artery a round, firm, and white clot, about three inches in length, which had been pushed a little beyond the cut extremity of the artery by the force of the column of blood.

M. Baron,[2] Virchow, and Mr. Paget[3] first directed the attention of pathologists to the frequency and danger of obstructions in the pulmonary artery.

Crampton, Louis, Bougen, Desault, Duncan, and others, have recorded cases of the obstruction of the larger bloodvessels by fibrinous coagula, and Dr. Reid,[4] Hodgson,[5] Andral,[6] Tiedemann,[7] Otto,[8] Lobstein,[9] Cloquet,[10] Carsewell,[11] Langstaff,[12] and others, have recorded cases of, and discussed the origin and mode of formation of phlebolites.

Dr. Benjamin Ward Richardson,[13] after the careful examination of the condition of the blood after death in 543 cases, occurring in man and in the inferior animals, including, in the human subjects,

[1] Memoirs of the Royal Academy for the year 1732.

[2] Recherches et Obs. sur la Coagulation du Sang dans l'Artere Pulmonaire et ses Effets, Arch. Gén. de Méd., sec. iii. t. ii.

[3] Paget on Obs. of Pulmonary Artery, Med.-Chir. Soc. Trans., London, vol. xxvii. pp. 162 and 280; see also Professor Simpson's Obstetrical Works, vol. ii. p. 34.

[4] Pathological Researches, 1848, p. 395.

[5] Treatise of Diseases of Arteries, p. 521.

[6] Anatomie Pathologique, t. ii. p. 412.

[7] Journal Comp. du Diction. des Sciences Méd., t. iii.

[8] Path. Anat. Trans., by South.

[9] Anat. Pathol.

[10] Path. Chirurgical.

[11] Cyclop. of Practical Medicine, art Veins.

[12] London Medico-Chirurgical Transactions, vol. viii. p. 287.

[13] "The Fibrinous Constituent in Relation to Disease," by B. W. Richardson, Medical Times and Gazette, Feb. 12, 1853. Ranking's Abstract of Med. Sci., June, 1853, p. 76, Am. ed. "Diagnosis of Fibrinous Concretions in the Heart," by B. W. Richardson, Assoc. Med. Journal, April 13, 1855. Ranking's Abstract of Med. Sci., June, 1855, No. xxi. p. 73, Am. ed. "The Cause of the Coagulation of the Blood, the Astley Cooper Prize Essay for 1856," by Benjamin Ward Richardson, M. D., London, 1858. "On the Diagnosis of Fibrinous Concretions in the Heart in certain cases of Inflammatory Croup," by B. W. Richardson, Med. Times and Gaz., March 8, 1856. Ranking's Abst. Med. Sci., No. xxiii., Jan.—June, 1856, p. 76, Am. ed.

deaths from sudden syncope, epilepsy, apoplexy, enteritis, croup, pneumonia, bronchitis, bronchorrhœa, phthisis, mesenteric disease, purpura, acute rheumatism, dropsy following scarlet fever, cyanosis, hæmoptysis, failure of the heart from fatty change, cancer, aneurism of the aorta, atheromatous and ossific disease of the aorta, adhesion and ossification of the pericardium, simple starvation, cirrhosis, degeneration of the heart from drunkenness, hydrocephalus, lateral compression of the chest, ulceration and stricture of the œsophagus, icterus, general dropsy from mitral disease, dilatation of the right side of the heart, senile decay, and hanging—including, in the human fœtus, deaths in the sixth, seventh, eighth, and ninth months of development, and soon after delivery, from various causes, mechanical and morbific—including, in pigs, sheep, oxen, dogs, cats, rabbits, guinea-pigs, and birds, deaths from hemorrhage, intestinal obstruction, poisoning from narcotic gases, chloroform, ether, smoke of puff-ball, carbonic acid, tobacco-smoke, antimoniuretted hydrogen, and prussic acid, poisoning by solid opium, salts of ammonia, potassa, and antimony, strangulation, drowning, electric shock, simple exposure to cold, peritoneal dropsy naturally and artificially produced, shock from blows on the head, extraction of the kidney, and inhalation of oxygen and chloroform, decided that the arguments were conclusive for the formation, in certain conditions of the blood, and of the circulation and respiration, of fibrinous masses previous to death.

Dr. Richardson, not content with these extensive observations, demonstrated, by well-devised and conclusive experiments, that fibrinous concretions can be artificially produced in animals during life, by the introduction into the blood of those substances which disturb the circulation and respiration, and the relations of the constituents of the blood to each other, and to the capillaries, and to the processes of secretion, nutrition, and excretion.

The hearts of the living animals were opened, and the fibrinous concretions withdrawn whilst the organs were still pulsating.[1]

The Conditions most favorable to the Deposition of Fibrinous Concretions.

The experiments and observations of numerous pathologists and physiologists have shown that the leading conditions for the deposition of fibrinous concretions in the circulatory apparatus during

[1] "The Cause of the Coagulation of the Blood," pp. 60–140.

life, are actual and relative increase of the fibrin of the blood and impeded circulation.

The *positive increase of fibrin*, which occurs in diseases of the acute inflammatory class, is frequently attended by a deposition of that portion of the fibrin which can be no longer held in solution by the blood, and thus cause death. In twenty-three cases of death from acute inflammation of the respiratory organs, and which ended fatally in the first stages by rapid sinking, Dr. Richardson[1] found in every case a fibrinous concretion, which he considered as due, in great part, to the excess of fibrin in the blood.

This observer substantiated this view by a series of experiments upon the inhalation of oxygen, which Dr. Gairdner had shown would increase the quantity of fibrin in the blood. After continuing the inhalation of oxygen for a considerable length of time, all the symptoms of fibrinous deposition were produced, and an examination of the living heart showed the presence of the concretion.

When the other elements of the blood are diminished, whilst the fibrin remains in normal amount, when compared to the previous quantities of the constituents and volume of the blood, but relatively increased to the altered proportions, the fibrin may be deposited. This kind of separation has been observed to occur after profuse purging, or after profuse colliquative sweating, and in cases of cholera, and in the last stages of phthisis pulmonalis, and in anemic conditions of the blood.

Disturbances in the circulation arising from simple failure of the heart, appear to be frequently attended by the deposition of fibrinous concretions.

This tendency is marked in all cases of slow death, when the action of the heart is enfeebled, and the struggle for life is prolonged, irrespective of the amount of the fibrin, whether increased or diminished, as in typhus and malarial fevers, and in purpura, and old age, and in debilitated states induced by ardent spirits and dissipation, and exposure and privations.

The deposition of fibrin in the circulation may result from other causes far more obscure and difficult of demonstration and investigation than those just enumerated. Thus, it has been observed that these concretions are more common in some seasons than in others. This fact would seem to indicate an atmospheric cause, or

[1] Loc. cit., p. 69.

certain revolutions in the human system, and in diseases. This fact shows the impropriety of drawing wide and absolute conclusions from a single series of investigations on the relative frequency of the formation of these bodies in different diseases.

The presence of certain foreign bodies in the blood may lead to the deposition of fibrin, as Gaspard and Lee conclusively demonstrated, by the injection of pus into the blood of living animals; whilst, on the other hand, the experiments of Magendie demonstrated that the injection of putrefying substances may produce the opposite condition—permanent fluidity of the blood.

Alterations in the constitution of the walls of the capillaries and bloodvessels and heart may produce the deposition of fibrin, and even the coagulation of the blood, as has been conclusively demonstrated by the experiments of Hewson,[1] Thackrah,[2] Sir Astley Cooper,[3] and Brücke.[4]

The normal reaction of the blood is alkaline, and it is a well established fact that the alkalies are solvents of fibrin—in fact, the theory proposed and ably advocated by Dr. Richardson,[5] ascribes the solution of the fibrin in the blood, to the presence of ammonia; if, then, the alkalies of the blood be neutralized by an acid generated by morbific processes within the blood, or absorbed from without, then we would expect the deposition of the fibrin. Now, in malarial fever, in which these concretions are common, the secretions of the mouth and the urine are intensely acid. I do not feel warranted, however, in propounding this as even a hypothesis, as I have found the blood in severe malarial fever alkaline, whilst the secretions of the mouth and urine changed the litmus blue to red, as rapidly and decidedly as a strong solution of sulphuric acid. The degrees of alkalinity of the blood of malarial fever are, however, worthy of careful investigation.

[1] An Experimental Inquiry into the Properties of the Blood, with Remarks on some of its Morbid Appearances. William Hewson: London, 1771. Experiments xxii. to xxvii., pp. 82–88.

[2] An Inquiry into the Nature and Properties of the Blood in Health and in Disease, by Charles Turner Thackrah; first ed., London, 1819; second ed., London, 1837, pp. 77–83.

[3] As quoted by Mr. Thackrah in his Inquiry on the Blood, second ed., 1834, pp. 83–85.

[4] An Essay on the Cause of the Coagulation of the Blood, by E. Brücke, M. D., British and Foreign Medico-Chirurgical Review, No. xxxvii., January, 1857, p. 141, Am. ed.

[5] Cause of the Coagulation of the Blood, pp. 229, 330.

Symptoms and Diagnosis of Fibrinous Concretions in the Heart and Bloodvessels.

In order that the connection of these heart-clots with the phenomena of malarial fever may be placed in the strongest light, we will illustrate this branch of our subject, not by our own observations, but by those of a far more able and experienced observer and experimenter.

Dr. Benjamin Ward Richardson thus describes the symptoms and diagnosis of fibrinous concretions in the heart, in his model work on the cause of the coagulation of the blood:—

"The symptoms produced by fibrinous deposition in the heart, are strikingly characteristic when they are once understood. But as they are commonly superadded to other symptoms, and appear at the acme or near the end of a disease, they occasion great perplexity to all who are not prepared to read them off, and whose attentions are bent to some more local mischief, by which the disease perchance is misnamed, rather than to the grand changes which are occurring in the body as a whole.

"Whatever be the disease, the effects of a fibrinous deposition are in the main the same, according to the manner in which the deposit itself is laid down. In other words, the symptoms depend on the position, form and character of the deposit, less than on the pre-existing malady. Whenever fibrinous deposition takes place in the heart during the course of a disease, the pure symptoms of the disease are lost or masked by the new symptoms which are set up, and which take to themselves a general representative position.

"The advantages which I have had for tracing out the symptoms produced by concretion, and for confirming, by dissection, the diagnosis instituted, have been confined mainly to cases where active inflammatory mischief (hyperinosis) has been the forerunning disorder. I write, therefore, from these sources of natural information.

"All symptoms of acute inflammatory diseases are attended with some risk of fibrinous deposition. Taking the majority of such cases, the risk is certainly small; but it is present in each case, and what renders the risk more serious is, that such risk or tendency to deposition cannot be measured by the local indications of inflammatory mischief in any given case, nor yet by the general symptoms which accompany the local. The symptoms of concre-

tion may intervene in the mildest, as well as in the severest cases. They may creep on insidiously; they may take effect in a sudden and unexpected outbreak. The following is an outline of a case in which the symptoms are unexpected. I write as I have seen, and as others have seen. A patient is suffering from an acute inflammatory attack. The local mischief, be it pneumonia, bronchitis, erysipelas, peritonitis, rheumatism, is not in itself such as to cause immediate alarm. The symptoms go on from visit to visit, and the patient is left on one of these occasions, not apparently in imminent danger. Unexpectedly there is a sudden call for the practitioner. He goes, and in the universal change that has occurred, he reads off the death signals. The man will sink. The fact, as it is written in the patient, is not to be described in words, but is easily learned from experience; it is written in the face of the sick man, in the restlessness, in the expression altogether. Whoever knows disease, knows at once, without further comment, what I mean. It is my business to show how far this *finale* of inflammatory disorders results from fibrinous deposit, and to indicate how the symptoms, when studied in detail, yield the diagnosis of concretion.

"If my observation of the last symptoms, and of the pathology of the cases thus referred to, be correct, the origin of the symptoms is connected with obstruction on the right side of the heart in the majority of instances. The obstruction may be on the left side; but the occurrence is comparatively rare, and the symptoms themselves are modified in detail by the difference in the point of obstruction. Taken generally, the symptoms of fibrinous obstruction on the right side are those which might be anticipated, on *à priori* physiological reasoning, as necessarily incident to obstruction of blood-making towards the pulmonic circuit. They are the symptoms of arrest in the nutrition and life of the body. They are characterized primarily by a peculiar and distressing dyspnœa. This occurs, not because the respiration is checked, for the respiratory murmur may be audible enough, but because the current of blood to the lungs is in part cut off. As an *addendum*, emphysema of the lungs, especially in children, results; and the physical signs of this lesion are often a valuable corroboration of the presence of concretion of the right side. *The dyspnœa depends on the deficiency in the supply of blood to the lungs and the nervous centres. The left side of the heart being imperfectly supplied with blood, the arterial circulation is weakened; the pulse is small and intermittent; the surface*

of the body is cold, and generally white as marble; but, as there is stagnation of blood in the venous circuit, the more vascular parts, as the lips and centre of the cheeks, are often of a leaden hue. There is general muscular prostration; and, as the brain is not supplied normally with blood, the muscles are not under the control of the will, but are in a continued restless motion. The mind loses its power; the acts of excretion are performed involuntarily; and death sets in, the gasping respiration outliving the paralyzed and obstructed heart.

"The symptoms thus portrayed are applicable to cases in which they last for several hours; in such examples the concretion is either lodged in the right auricle, or is being laid down as a tube in the infundibulum and pulmonary artery, or is commencing at the extremities of the pulmonary circulation. But other cases occur, where the course of the symptoms is suddenly cut short. There may have been some slight premonitory symptoms, but the suddenness of the end is the great fact. The patient, previously exhausted, is rising in bed, or making some muscular movement or strain, when suddenly he reclines or falls, breathless, faint, feebly convulsed, dead. I have met with two illustrations of this last event. The cause in both cases was the same, and the cause is ordinarily the same; the pulmonary artery is suddenly blocked up with a fibrin cylinder. In each of these cases, observed by myself, this cylinder has been hollow, and had conveyed a stream of blood like a tube. Its base had commenced in the infundibulum; its apex had ascended into the pulmonary artery. The concretion had been suddenly torn from its attachments, and carried up into the artery. In its centre was a column of red clotted blood; externally it was encased in a thin layer of blood, the result of a rush of blood past the concretion after its detachment.

"Once more, there are instances where the symptoms are unusually prolonged. In one instance which I observed, the symptoms of dyspnœa extended over many days, and anasarca supervened as a result of the obstruction. The concretion in this instance commenced in the auricula, where it had a firm attachment, and sent a prolongation downwards into the ventricle. In the case supplied by Dr. Sayer the symptoms of dyspnœa extended over many months; and Mr. H. Lee has recorded an instance in which a similar extension of symptoms occurred.

"When the concretion is deposited on the left side of the heart, the ventricle, the infundibulum, and the ascending portion of the aorta are the most common positions. The symptoms which cha-

racterize the presence of concretion here situated are different in many respects from the preceding. There is a tumultuous action of the heart, a symptom which is strikingly indicative that the deposit is on the left side. *There is congestion of the lungs and suffocative dyspnœa, with expectoration, sometimes mixed with blood. The surface of the body is of a leaden color, and the body is cold. The muscular perturbation lapses into powerful convulsions, and coma precedes dissolution.* These symptoms may extend over may hours.

"But, as in the preceding class of cases, the symptoms may also occur in a sudden manner. The patient, in moving or making a straining effort, suddenly falls back, is seized with a violent convulsive fit, and so expires. I once saw these symptoms and this sudden form of death in an old lady, who had previously suffered from no other symptoms than a slight attack of cold. In rising from bed, she fell, as I have described, and died before medical assistance could be obtained. In this case the concretion had formed as a hollow cylinder in the infundibulum of the left ventricle, had become dislodged, and had been carried into the aorta, which it entirely occluded.

"Again, the symptoms of the concretion may extend over a long period. The concretion may, as I have shown, become organized. In such case the symptoms are those of valvular obstruction on the left side. Such cases often end suddenly at last. Cases may be met with in which concretions exist on both sides of the heart at the same time. In such instances, unless the concretion on the right side be small, or placed out of the direct course of the circulation, the symptoms partake of the characters which belong to deposition in the right cavities.

"The pre-existence of disease of the heart, either acute or chronic, favors materially the deposition of fibrin. We have seen in acute endocarditis how this obtains. It is easy to see, and cases abundant are on record for illustration, to what extent dilatation of the heart, feebleness of its walls, or induration of its valves, favors the formation of concretion.

"I have often been asked whether there are no reliable physical diagnostic signs of concretion. I think not. There are sometimes abnormal sounds, but it is difficult to distinguish these from murmurs, the results of valvular lesion. The tumultuous action of the heart, taken with the general symptoms, is always a valuable diagnostic mark of concretion of the left side; but this is compatible with other diseased conditions. The weak, irregular action

is, with the general symptoms, always a valuable diagnostic sign in concretion of the right side; but it is equally compatible with other causes. In some cases, where the concretion interferes with the action of either the auriculo-ventricular or semilunar valves, there is a muffled character with the sounds, dependent on the obstacle to the play of the valves by the tension of which the sound is produced. But as it is scarcely ever the fact that both sets of auriculo-ventricular valves, or both sets of semilunars, are affected simultaneously by concretion, loss of either sound is of rare occurrence. In short, the only physical signs of moment are, feebleness of action, tumultuous action, or occasionally a peculiar rumbling, fidgety, jog-trot motion, with which the two sounds are heard in natural sequence as regards each other, but irregularly and lispingly. *The diagnosis must therefore rest upon the general symptoms, rather than on the physical.* The nature of the case must be considered. All acute sthenic inflammations form favorable pre-existing conditions; pneumonia foremost of all. The puerperal state is second to none in this particular, and the symptoms of concretion are often as insidious as they are sudden. I do not speak here of puerperal phlebitis, and of deposits in the veins, but of cases where there has been no outward sign, either during pregnancy or after parturition, and where the woman suddenly succumbs, without any preliminary indication of acute disease. In these instances, unattended with pre-existing changes in the venous trunks, or evidence of inflammatory lesion, we can only, in the present state of our knowledge, assign as a cause of the deposition excess of fibrin in the blood, arising from absorption of the thickened uterine walls, or suppressed lacteal secretion, or neutrality or deficiency of the fibrin solvent. I have more than once seen a sharp inflammatory attack, without direct evidence of organic inflammation, end fatally by the deposition of concretion. Many cases of so-called "simple inflammatory," or perhaps "continued fever," are of this character. After death it is found that there has been an inflammatory affection of some organ, but that such affection has not been diagnosed. In these examples the spleen is often the organ which has suffered the local lesion, but the symptoms have not been sufficient to be readily detected during life.

"By some observers, who admit that the fibrinous deposit may be formed before death, an argument is sometimes used that such concretions are always formed in the last hours of existence, and that they are rather the sequences of the dying state than its

precursors and final cause. To some extent this argument has weight; for there are cases certainly in which these concretions are found, where the inference is fair that death would have occurred though the concretion had not existed. On the other side, various instances have been given, where both the symptoms and the pathology show that the concretion was the inevitable cause of dissolution. In other words, the patient would not have died if the concretion had not been formed. Moreover, in all cases where the deposit occurs this is clear, that in the majority of cases it is the final seal and bond to the death claim.

"The question may be asked, Of what good is this knowledge concerning concretions in the heart? Why be anxious to learn the existence of a cause of death, which, by its irremediability, may be considered death itself? I answer, great good. I am not without hope that the day may come when science shall show us how the dissolution of these concretions may in some cases be effected; for I have seen them partly dissolved as an effect of alkaline treatment.

"But irrespective of this matter, the correct diagnosis of concretion is a guide to prognosis, and is a guide against many forms of meddlesome and mischievous, because useless, practice. Take two examples: In the latter stages of inflammations, bleeding is notoriously bad practice. The reason is obvious; and I regret to say I have seen the evil too obviously and practically explained. In these cases, the tendency of the disease is towards fibrinous deposition; and the tendency of hemorrhage is towards the same event. Therefore, as the practitioner bleeds, the balance of the blood-constituents, already disturbed, is disturbed the more; all that was wanting to secure deposition is secured; the circulation is enfeebled, and the proportion of water and fibrin is increased. The deposit forms, and the patient sinks. In one instance of pneumonia I saw the fatal symptoms of concretion on the right side follow the free abstraction of blood, as clearly as the symptoms of narcotism can ever be observed to succeed upon the administration of an opiate. For the same reason, in the latter stages of acute inflammatory affections, it is equally dangerous to carry the depressing system by medicines to an extreme, or to produce too free an elimination from the body; of all medicines, in such stages, purgatives and opiates should be alike avoided. Lastly, the correct diagnosis of concretion in the heart may prevent unnecessary surgical interference, and explain the reason why some measures, conducted on the most

scientific surgical principles, miss their intended object. This is strikingly illustrated in the disease, true inflammatory croup. In this affection, as I have proved by repeated inspections, concretions definitely formed from blood in motion, and long before death, are often found in the heart after death has occurred. Further, I have been able in this disease to trace the symptoms of concretion as clearly as I had previously traced the special, local, or inflammatory symptoms of the disorder. Thus, in croup there may be death from one of two sources: from the obstruction in the larynx—asphyxia; from the obstruction in the heart—syncope; or from the combination of these. If, then, the symptoms are clearly those of pure asphyxia, dependent obviously on the obstruction in the air-passages, the operation of tracheotomy is the grand remedy. But if the stethoscope tells that the air enters the lungs with moderate freedom at each inspiration; if indications of emphysema are present; if the symptoms are those of obstruction at the heart—syncope—then is the operation of tracheotomy as useless as would be that of phlebotomy for removing a solid plug from the windpipe."[1]

A careful comparison develops a close resemblance between the symptoms of concretions of fibrin in the heart and bloodvessels, and many of the symptoms of the cases of congestive malarial fever now recorded.

In view of the rapid, feeble, intermittent pulse; disturbed, full, panting respiration; rapid, feeble, fluttering action of the heart; cold extremities, exhaustion of the muscular forces, stupor, wandering of the intellect, inability to control the muscles, and acts of excretion; in view of the sudden onset of all these symptoms in malarial fever; in view of the size and structure of the coagula found in the heart and bloodvessels after death, in the cases presenting these symptoms; in view of the close correspondence of these symptoms with those characteristic of the deposition of fibrin in the heart and bloodvessels; in view of the observations and experiments of Baillie,[2] Morgagni,[3] Albinus,[4] Burns,[5] Hewson,[6] Gould, Templeman, Haller, Stewart,[7] Graham,[8] Chisholm,[9] Ward-

[1] Cause of the Coagulation of the Blood, pp. 423–434. *The Italics are our own.*

[2] Trans. of A. Soc., vol. i.

[3] Annot. Academ., lib. vii. c. 2.

[4] Epist. 36, art. 10.

[5] Diseases of the Heart.

[6] An Experimental Inquiry into the Properties of the Blood, 1771.

[7] Ed. Med. and Surg. Journal for 1817.

[8] Med.-Chirurg. Transactions, vol. v. p. 297.

[9] An Epidemic Polypus in Granada in 1790.

rop,[1] Cruwell,[2] Stenzel,[3] Petit, Martial,[4] Baron,[5] Virchow,[6] Bouillaud,[7] Meigs,[8] Davy,[9] Fuller, Simon,[10] Simpson,[11] Paget,[12] Crisp,[13] Kirkes,[14] Wagner,[15] Rokitansky,[16] Richardson,[17] and others, we are justified in asserting that the fibrinous element of the blood may be deposited in the heart and bloodvessels during life in malarial fever, and not only give rise to a distinct set of phenomena, but cause death in cases which otherwise would not have terminated fatally.

The evil effects of the deposition of fibrin in the bloodvessels are by no means confined to the period attending and immediately succeeding their formation. These fibrinous bodies, wherever formed, and whatever be their situation, are full of peril, and may remain so long after the circumstances which gave rise to them have passed away. The observations of Dr. Wm. Senhouse Kirkes[18] have demonstrated that the large masses may at any time be detached from the points to which they were originally attached (the valves of the heart and bloodvessels, or the carneæ columnæ, or chordæ tendi-

[1] Baillie's Works, vol. ii. p. 20.

[2] De Cordis et Vasorum Osteogeneses in Quatrogenario Observata; Halæ, 1767.

[3] Dissertationes de Steatomatibus Aortæ.

[4] Memoirs of the Royal Academy for the year 1732.

[5] Recherches et Obs. sur la Coagulation du Sang dans l'Artere Pulmonaire, et ses Effets; Arch. Gén. de Méd., sec. 14, t. ii.

[6] On Plug Formations and Obstructions in the Bloodvessels; Handbuch der Speciallen Pathologie und Therapie; Erlangen, 1854, Erstes Bande.

[7] Traité Clinique des Malades du Cœur, Apendice, tome ii., Paris, 1835.

[8] Philadelphia Medical Examiner, No. 51, 1849.

[9] Physiological and Anatomical Researches, London, 1839.

[10] Animal Chemistry, 1843. [11] Obstetrical Works.

[12] On Obstructions of the Branches of the Pulmonary Artery, Med.-Chir. Trans., vol. xxvi., 1844.

[13] On the Structure, Diseases, and Injuries of the Bloodvessels, 1847.

[14] On some of the Principal Effects resulting from Detachment of Fibrinous Deposits from the Interior of the Heart, and their Mixture with the Circulating Fluid, Lancet, June 5, 1852; Ranking's Abstract, 1852.

[15] Elements of Physiology. [16] Manual of Pathological Anatomy.

[17] Cause of the Coagulation of the Blood, 1858. The Fibrinous Constituents of the Blood in relation to Disease, Medical Times and Gazette, Feb. 12, 1853. Diagnosis of Fibrinous Concretions in the Heart, Assoc. Med. Journal, April 13, 1855. See also Turner, Thackrah on the Blood, 1819. An Essay on the Cause of the Coagulation of the Blood, by E. Brücke, British and Foreign Medico-Chirurgical Review, No. xxxvi., Jan., 1857, p. 141, Am. ed.

[18] On some of the Principal Effects resulting from Detachment of Fibrinous Deposits from the Interior of the Heart, and their Mixture with the Circulating Fluid, London Lancet, June 5, 1852.

næ of the heart), and conveyed with the circulating blood until arrested within some arterial channel, which might thus become completely plugged up, and the supply of blood to an important part be suddenly cut off, from which serious if not fatal results would ensue; or smaller masses might be detached, and pass on into arteries of much less size, or even into the capillaries, and produce stagnation and coagulation of the blood, and all the attendant changes and phenomena; or the masses of fibrin may soften, break up, and discharge the finely granular material resulting from their disintegration into the circulating blood, and contaminating the fluid, might excite symptoms very similar to those observed in phlebitis, typhus, and other analogous blood-diseases. The parts of the vascular system to which these detached masses of fibrin would be transmitted, will depend upon the parts of the circulatory system from which they are detached; thus, if detached from the left heart, they would pass into the aorta and its branches, and produce various disturbances in the nutrition, secretion, and functions of the organs; and if detached from the right heart, the lungs would become the primary, if not the exclusive, seat of their ultimate deposition.

We will hereafter record cases presenting certain symptoms, which might be referred to the detachment of these fibrinous concretions, and their subsequent lodgment in different organs.

In affirming that death may be, and is often produced in malarial fever by the deposition of fibrinous concretions, we do not for one moment lose sight of the fact that the great questions after all to be settled are: What produced this state of things, favorable to the formation of these concretions? What are the chemical and physical changes of the blood and of the bloodvessels? What are the causes of the disturbance of the action of the heart and capillary circulation, which precede and determine the deposition of the fibrin of the blood?

The correct answer of these questions involves the complete knowledge of the physical and chemical relations of fibrin to the elements of the blood, and to the bloodvessels and surrounding tissues; involves the complete knowledge of the origin and offices of fibrin in physiological and pathological conditions; involves a knowledge of the physical, chemical, physiological, and pathological relations of morbific agents, not only to the fibrin, but to all the constituents of the blood, and to the containing vessels, and to the organs, and tissues, and apparatus. The impossibility of answer-

ing these important questions is immediately seen, when we review the whole controversy concerning the cause of the coagulation of the blood, the knowledge of which should form the starting-point in the attempt to solve these difficulties.

We are actuated by no disparaging or captious spirit when we assert that, notwithstanding the laborious investigations of Hewson, Thackrah, Richardson, and Brücke, we have no theory which will explain satisfactorily and thoroughly the coagulation of the blood under all circumstances; when we assert that the theories thus far proposed are expressions rather of necessary and attending circumstances for the manifestation of the phenomena of coagulation, than of the true causes; when we assert that notwithstanding the observations and reasonings of Mulder, Paget, Simon, Carpenter, Virchow, Brücke, and others, the origin, offices, and ultimate changes of fibrin are still matters of dispute, and are questions to be determined by future observation and experiment.

If we adopt the hypothesis of Dr. Richardson, that the fibrin of the blood is held in solution by ammonia, and that the coagulation of the fibrin is due to the escape of the ammonia, the most important questions, in a physiological, as well as in a pathological point of view, with reference to the true causes of the coagulation of the blood, remain unsettled.

It has not as yet been determined what are the physical and chemical properties upon which these relations of fibrin and ammonia are dependent; the origin and variations in quantity of the ammonia in different physiological and pathological states, and its relations to the other constituents of the blood, have been only barely indicated, and not determined; and no hypothesis yet propounded explains the phenomenon of the more rapid coagulation of blood in a dead than in a living heart or bloodvessel; and no series of experiments have yet settled definitely and absolutely the question, whether fibrin exists as fibrin in the blood, or is formed by a chemical change at the time of coagulation.

If we adopt the hypothesis that fibrin is held in solution in the living body by nervous and vital influences, and that its coagulation is due to the abstraction of nervous and vital influence, the questions immediately arise, What are nervous and vital influences? How are they produced? What are their relations to fibrin?

If we adopt the hypothesis of Dr. Richardson, that the primary and essential part of the process of coagulation consists in the evolution of a volatile principle, and that the volatile principle thus

eliminated from blood, is ammonia, the questions immediately arise: Does this ammonia which holds the fibrin in solution, decrease in the latter stages of malarial fever, and in the latter stages of all those diseases in which fibrinous concretions are formed before death? What are the causes of the decrease of ammonia? What are the disturbances in the chemical changes of the living organism, which lead to this decrease of ammonia?

If we adopt the hypothesis, supported by the experiments of Hewson, Thackrah, Cooper, Brücke, and others, that the solution of fibrin in the living body is dependent upon its relations with the walls of the containing heart and bloodvessels, the main question to be settled is, What are these relations, and upon what are they dependent, and how may they be disturbed?

If we adopt the hypothesis so ably advocated by Brücke, that the fibrin exists not as fibrin, but as a soluble albuminate, and is formed at the moment of coagulation, at the expense of a portion of the albumen of the blood, by a change in its atomic constitution, and that these changes are prevented during life by an influence exerted by the coats of the living bloodvessels: the cause and character of these chemical changes of the albumen, and the cause and character of the influence of the coats of the living bloodvessels upon the blood, are still unknown.

If, with Zimmerman, we think that the coagulation of fibrin is nearly allied to the process of fermentation, which may be regarded in the light of an oxidizing process, and is brought about by a kind of putrefaction occurring in some of the constituents of the blood, after its removal from the body, the questions are still unanswered: What is this oxidizing process? Why does it not take place in the circulating blood, which is not deficient in oxygen? What is this peculiar kind of putrefaction, and what previous chemical changes does it involve? What is the nature of the putrefactive process which leads to the deposition of fibrin in the living heart and bloodvessels in malarial fever, and other diseases?

If we combine the truths of all the hypotheses of the coagulation of the blood thus far propounded, we will have the same number of important questions to be determined.

If we say that the formation of fibrinous concretions in malarial fever is due to impeded circulation; while we express a valuable fact, leading to the development of important principles of treatment, we do not, by any means, explain the phenomena of the deposition of fibrin, but only state one of the favorable circum-

stances, and besides the important questions which we have propounded with reference to every hypothesis of coagulation, thus far advanced, the question still remains: What produced the retardation of the circulation? If the retardation of the circulation was due to the effects of the malarial poison, what are those effects? where, when, and how did the poison act? Did the poison act alone upon the structures of the circulatory apparatus? or did the poison act primarily upon the blood, and through the altered constituents of the blood upon the nutrition and development of the forces of the circulatory apparatus? or did the poison in the altered products of the blood act upon one or both the nervous systems, and through them produce such irregularity and feebleness in the circulatory apparatus, as led to the deposit of fibrinous concretions.

Notwithstanding that the facts now recorded are not sufficiently numerous, to warrant the assertion that fibrinous concretions are formed previous to death, in every case of malarial fever; notwithstanding that the causes of the formation of these clots are obscure, complicated, and unknown; notwithstanding that the causes of death may not be connected with those which lead to the deposition of fibrin in the living vessels; we may, nevertheless, assert that the knowledge that these concretions may and do form in many cases of malarial fever, and produce a fatal termination in cases which would not otherwise have thus terminated, is of the utmost value to practitioners of medicine in the South and Southwest, where the severest grades of malarial fever prevail.

Principles of Treatment best adapted to prevent the Formation of Fibrinous Concretions in the Heart and Bloodvessels.

When the pulse is rapid and feeble, beating from 120 to 160 times in a minute, and feeling like the vibrations of a delicate silver thread; when the heart thumps, feebly, and spasmodically, and rapidly against the walls of the thorax; when the respiration is full, panting, labored, varying from 30 to 50 in the minute; when the skin is hot, and parched, and rough, or bathed in a cold clammy sweat; when the temperature of the extremities is far below that of the trunk, which by no means corresponds with the increased efforts at the introduction of oxygen; when the circulation of the blood in the capillaries of the extremities is almost entirely checked; when the chemical changes of the solids and fluids are in a great measure arrested, and perverted, and the development of the nerv-

ous and physical forces arrested, and their correlation disturbed; when the altered blood stagnates in the capillaries of the brain, and the intellect is either abnormally excited or depressed; when the altered blood stagnates in the capillaries of the tongue and stomach, and the brilliant red, dry, rough tongue, is but a fit index of the consuming thirst of the restless patient tossing from side to side, and pleading for a drop of water; we have all the disturbances necessary for the formation of fibrinous concretions, and the treatment must be energetic and prompt.

The torpid nervous centres must be aroused; the feeble general and capillary circulations must be aroused; oxygen must be rapidly introduced, and correspondingly rapidly distributed through all parts of the system; the chemical changes by which the muscular and nervous forces and heat are developed and maintained, must be excited and maintained with energy, by the rapid distribution of the elements of chemical change; the products resulting from these chemical changes, and from the changes induced in the constituents of the blood and organs, by the malarial poison, must be removed.

Those remedies should be employed, which excite the general and capillary circulation; promote the introduction and distribution of oxygen; increase the chemical changes, and excite the development of the muscular and nervous forces.

Sulphate of Quinia and diffusible stimulants, Brandy and Carbonate of Ammonia, should be freely and promptly administered, and sinapisms freely applied.

Bottles of hot water, or better still, the hot bath, should be used to impart heat, and stimulate the capillary circulation, and relieve the engorgement of the large organs.

Brandy and Red Pepper may be applied to the surface with advantage.

The Sulphate of Quinia may be administered to adults in doses of 5 to 30 grains, every one, two, or three hours, according to the urgency of the symptoms, up to from 30 to 80 grains during the twenty-four hours. The best method of administering the Sulphate of Quinia, is dissolved in a weak solution of citric or acetic acids, or in lemon-juice. It is much more readily and rapidly absorbed, in the soluble form. If the stomach rejects the Sulphate of Quinia, it should be administered in solution with starch, by the rectum.

Every practitioner of medicine in the Southern and Southwestern districts of the United States who has employed the Sulphate of

Quinia in large doses, is aware of the surprising rapidity with which, in many cases, the most alarming symptoms of congestive fever will be dissipated by the action of sulphate of quinia in large doses. The patient will frequently be snatched from the very jaws of death, and be blessed with a recovery as rapid as his attack. In such cases, we must conclude that the action of Sulphate of Quinia alone is able to prevent the formation of fibrinous concretions.

The Sulphate of Quinia prevents the deposition of fibrin in the blood, by its direct action upon the sympathetic and cerebro-spinal nervous systems, or by its excitement of the general and capillary circulations, either directly, or through the nervous system, or by its relations to the chemical changes of the elements of the blood and malarial poison, or by its action in all these modes combined.

Diffusible stimulants should be administered because they act more rapidly in exciting the nervous systems and in arousing the circulation, than the sulphate of quinia.

If the formation of fibrinous bodies in the heart and bloodvessels be common in malarial fever, and if the statement of Dr. Benjamin Ward Richardson, of London, that the fibrin is held in solution in the liquor sanguinis of the living bloodvessels by Ammonia be true, and if, as we shall hereafter demonstrate by numerous facts and cases, the action of the malarial poison is depressing, and not inflammatory, then Carbonate of Ammonia should be administered freely in malarial fever. It should be administered freely in congestive fever when there is a feeble, rapid action of the heart, and diminished, aberrated forces, because it excites the general and capillary circulation; excites the chemical changes in the capillaries, necessary for the development of the muscular and nervous forces; arouses the sympathetic and cerebro-spinal nervous systems; promotes secretion and excretion; and furnishes the volatile alkali to the blood, which holds the fibrin in solution.

We do not for one moment advocate the Carbonate of Ammonia as a substitute for Sulphate of Quinia. The Carbonate of Ammonia does not cure the disease. The Carbonate of Ammonia merely arouses the system, prevents a distressing and fatal accident, and prolongs life until the Sulphate of Quinia can act. Stimulants and sinapisms also arouse the nervous system and circulation, and lead to an increased supply and distribution of the great element of chemical change (oxygen), and thus furnish the conditions of an increased development of the physical, chemical, muscular, and nervous forces; but they cannot cure the disease, they cannot di-

rectly remove, or chemically alter, or destroy the poison; they cannot, then, take the place of the Sulphate of Quinia.

To prevent the formation of fibrinous concretions in malarial fever, we must administer the Sulphate of Quinia in full doses, in conjunction with the Carbonate of Ammonia, stimulants, and the free use of sinapisms and the hot bath.

This course of treatment may be instituted regardless of the dry, red tongue, tender epigastrium, and wandering and torpid intellect, and distracting pains in the head. I have observed in numerous cases, that under the free use of stimulants, sinapisms, and large doses of the Sulphate of Quinia, the dry, harsh, hard, red, glazed tongue became moist, soft, and pale; the pulse diminished in frequency, and increased in fulness; the dry, harsh skin rendered moist; the cold clammy skin restored to its normal state; the relations between the circulation in the trunk and extremities restored; the correlation between the physical, chemical, vital and nervous forces restored; and the wild delirium succeeded by calm intelligence. Whilst on the other hand, in more cases than one, I have seen active purgation, and the administration of alterative doses of Calomel, convert cases of ordinary intermittent and remittent fever into the dangerous congestive type, resulting in the formation of heart clots and speedy death. When stimulants and Sulphate of Quinia have been withheld, I have seen the patient die from complete exhaustion of the nervous and vital powers consequent upon the action of the malarial poison, either directly upon the nervous ganglia of the sympathetic system, presiding over the circulation and respiration, or by disturbances of the relations existing between the sympathetic and cerebro-spinal nervous systems; or primarily upon the cerebro-spinal system and sympathetic system simultaneously; or by such changes in the elements of the blood (especially of the blood-corpuscles), as resulted in the perversion of the nutrition of the nervous ganglia; or by the generation of compounds in the blood, and in the secretions of the liver, spleen and alimentary canal, which acted as poisons upon the sympathetic and cerebro-spinal nervous systems; or by the simultaneous action of the poison in all these different modes.

Physical and Chemical Changes of the Constituents of the Blood in Malarial Fever.

The method of analysis[1] employed in these investigations is similar in many respects to that employed by MM. Becquerel and Rodier, Bowman, and others.

In the present state of physiological and pathological chemistry, objections may be alleged against every method of analyzing the blood, thus far proposed.

All physiological chemists have failed to ascertain with absolute accuracy the amount of solid matter in the serum of 1000 parts of blood; and there is no method by which the colored blood-corpuscles can be separated from the surrounding liquor sanguinis, and the chemical constitution and relative proportions determined with absolute accuracy. It is evident, therefore, that when we attempt to calculate the moist blood-corpuscles by the formula of C. Schmidt, whatever error entered into the calculation of the solid matters of the moist blood-corpuscles, will be increased fourfold, whilst the error in the calculation of the constituents of the liquor sanguinis will increase, not only in a direct ratio to the errors in the calculation of the blood-corpuscles and solid matters of the serum of 1000 parts of blood, but also in a definite ratio to the actual increase or decrease of the moist blood-corpuscles. That error exists in this method of analysis, is rendered evident when we calculate the constituents of 1000 parts of liquor sanguinis from the data obtained by subtracting the moist blood-corpuscles from 1000 parts of blood, and considering the remainder liquor sanguinis. The results thus obtained, do not correspond with those obtained from actual analysis of 1000 parts of liquor sanguinis. To render this error evident,

[1] Pathological Chemistry, by MM. Becquerel and Rodier. Translated by S. T. Speer, M. D. London, 1857, p. 19 et seq. Bowman's Medical Chemistry, pp. 145–194. Philadelphia, 1850. Simon's Chemistry of Man, p. 142. Philadelphia, 1846 Lehmann's Physiological Chemistry. Trans. by G. E. Day. Cavendish Society pubs., vol. ii. pp. 153–280. London, 1851–1854. See also American ed., edited by Prof. Rogers, vol. i. pp. 541–648. Manual of Blood and Urine, by Griffith, Reese, and Markwick. Philadelphia, 1848. Physical, Chemical, and Physiological Investigations upon the Vital Phenomena, Structure, and Offices of the Solids and Fluids of Animals, by Joseph Jones (American Journal of Medical Sciences, July, 1856, p. 46). Investigations, Chemical and Physiological, relative to certain American Vertebrata, by Joseph Jones. Smithsonian Contributions to Knowledge, 1856. Anleitung zur Qualitativen und Quantitativen Zoochemischen Analyse, von E. von Gorüp Besanez. Nurnberg, 1854.

I have in the succeeding analyses, stated the actual analysis of 1000 parts of liquor sanguinis, and that calculated from the constitution of the liquor sanguinis determined in 1000 parts of blood, by the subtraction of the moist blood-corpuscles. The former, by actual experiment, is always marked (1); the latter, by calculation, is always marked (2).

A perfect method of analyzing the blood will never be obtained, until it be possible to obtain the moist, colored, and colorless blood-corpuscles entirely free from the intercellular fluid, and without the loss of any of their constituents, or the introduction of any foreign bodies. As yet the method first applied by Figuier, and improved by Dumas and Höfe, the method of F. Simon, and the method of direct measurement and enumeration of the blood-corpuscles in a definite portion of blood, and, in fact, every method thus far proposed, is imperfect, and they have one and all failed to yield absolutely accurate results.

Whilst these failures should lead to caution, and the extension of experiments and investigations, they should by no means lead to the entire distrust and abandonment and condemnation of these observations; they should lead to an appreciation of the difficulties of the investigation, and of the exceeding complexity of the fluid substances to be examined; they should lead to an appreciation of the causes of the differences in the results obtained by different observers. When those parasites and vultures of the medical profession who make their living, in a great measure, by rehashing old objections, original neither with themselves nor their race, shall enter laboratories in sickly countries, reeking with the fumes of urine, blood, and brains, and demonstrate by actual experiment, the truth of their objections, and the feasibility of their plans of reform and improved investigation, they will be in a position at least to criticize, if not to propose something better. The following table will illustrate the changes of the blood in malarial fever:—

Table illustrating the Changes and Composition of Venous Blood in Malarial Fever.

	1	2	3	4	5	6	7	8	9
Specific gravity of blood	1042	1034	1030.5	1042.0	1042.4	1035.0	1042.4	1036.6	1040.0
" serum	1018	..	1021.3	1022.5	1021.3	1021.0	..	1023.6	1022.0
WATER—									
In 1000 parts of blood	830.509	850.888	877.553	831.294	827.901	860.976	839.589	840.511	833.449
" serum	929.287	920 820	927.757	927.853	928.370	923.786	912.779	913 950	912.386
(1) " liquor sanguinis	927.194	918.072	925.725	924.664	926 937	921.233	909.839	912.665	910.798
(2) " "	887.328	892.859	911.124	887.265	887.034	900.473	879.813	882.723	875.813
SOLID MATTERS—									
In 1000 parts of blood	169.491	149.112	122.447	168.706	172.099	139.024	160.411	159.489	166.551
" serum	70.713	79 180	72.243	72.147	71.630	76.214	87.221	86.050	87.614
(1) " liquor sanguinis	72.806	81.928	74.275	75.336	73.297	78.767	90.169	86.978	89.203
(2) " "	112.672	107.424	88.876	112.735	112.965	99.527	120.187	117.277	124 187
In serum of 1000 parts of blood	64.158	73.167	68.435	64.464	62.789	71.032	80.227	79.135	80.033
FIXED SALINE CONSTITUENTS—									
In 1000 parts of blood	7.532	7.692	3.316	4.310	4.041	7.317	7.500	5.796	6.314
(1) " liquor sanguinis	5.332	5.120	3 328	3.299	4.015	5.480	4.066	2.647	6.620
(2) " "	8.245	6.696	3.965	4.885	6.246	6.489	5 405	3.498	8.759
" solid matters of blood	44.439	51.586	27.083	25.906	23.202	52.631	46.754	36.341	37.909
(1) " " liquor sanguinis	77.931	64.648	45.901	45.576	56.338	71.902	46 387	30.178	75.558
" " blood-corpuscles	28.500	40.351	3.240	14.047	4.584	42.751	51.046	42.914	6.595
" moist blood-corpuscles	7.258	10.087	0·841	3.511	1.119	10.649	12.131	10.728	1.648
In blood-corpuscles of 1000 parts of blood	3.002	2.962	0.175	1.432	0.490	2.795	3.770	3.409	0 567
In serum of 1000 parts of blood	4.530	4.730	3.141	2.938	3.551	4.522	3.730	2.387	5.747
1000 PARTS OF BLOOD CONTAINED—									
Moist blood-corpuscles	413.732	293.620	207.948	407.764	431.508	262.448	309.936	317.748	343.872
Water of moist blood-corpuscles	310.219	220 215	155.861	306.823	323.631	196.836	232.452	238.271	258.804
Organic matters of moist blood-corpuscles	100.431	70.411	51.812	100 409	107.320	62 703	73.655	76.000	84.400
Mineral matters of moist blood-corpuscles	3.002	2.962	0.175	1.432	0.490	2.795	3 770	3.409	0.567
Liquor sanguinis	586.268	706.380	792.052	592.236	568.492	737.552	690.064	682.252	656.128
Water of liquor sanguinis	520.210	630.705	721.692	525.471	504.270	664.140	607.124	602 240	574.646
Organic matters	58.328	68.405	65.194	61.500	59.210	66.400	76.387	76 708	74.185
Mineral matters	4.760	4.730	3.141	2.301	3.551	4.522	3.730	2.387	5.747
Fibrin	1.900	2.540	1.925	2.938	1.433	2.380	2.710	0.877	1.450
1000 PARTS OF MOIST BLOOD-CORPUSCLES CONTAINED—									
Water	749.996	750.000	749.519	750.000	750.000	750.000	750.224	749.873	752.646
Organic residue	242.746	239.803	249.154	246.468	248 709	239.296	237.645	239.284	245 239
Mineral matters	7.258	10.087	0.841	3.511	1.119	10.649	12.131	10.728	1.648

The blood in No. 1 was abstracted from a stout, muscular English seaman, who had been exposed to the malarial poison in Jacksonville, Florida, and in Savannah.

Before the commencement of the bloodletting the skin was hot and dry, face flushed and red, respiration thoracic, pulse 106, temperature of hand 105, temperature under the tongue 106. The pulse was full, and the respiration deep and rapid. There was a rapid introduction and distribution of oxygen, and a corresponding increase of temperature, denoting an increase of chemical change. The patient complained of great pain in the head.

The patient appeared to be alarmed by the preparations for bloodletting, and when I appeared with the specific gravity bottles, beaker-glasses, and capsules to receive the blood, he fell back (he was standing) into the arms of the assistant, and in a few moments before the lancet was applied the perspiration stood in large drops upon his face and hands. During the bleeding he perspired freely, and fainted before f℥x were abstracted. The pulse and respiration were diminished in frequency and force, and the patient fell into a profound slumber, during which his clothes were saturated with a profuse perspiration. The temperature in the course of three hours was reduced to the normal standard, and the pulse and respiration diminished in frequency and force.

This case yielded readily to the action of sulphate of quinia, and was discharged three days after this observation.

The fact that the mere preparations for bleeding caused the patient "to break out into a profuse perspiration," may be accounted for in two ways. Either the cerebro-spinal system acted upon the sympathetic nervous system, and thus influenced the circulation, respiration, and skin, and through the circulation and respiration the chemical changes; or the sweating stage was nigh at hand, and the bleeding was the occasion and not the cause of its appearance.

In this case, the true explanation, which we will endeavor to substantiate hereafter by numerous facts, appears to be that the malarial poison excites the sympathetic and cerebro-spinal nervous systems, either by a direct action upon the nervous apparatus, or by an indirect action, by inducing chemical changes in the blood, especially in the blood-corpuscles, the altered products of which act as excitants to the nervous systems. Through the agency of these two systems, especially of the sympathetic, the respiration and circulation are increased in frequency and force. In other words, the

elements and conditions of chemical change are rapidly supplied to all parts of the body; hence the heat of fever. During these changes the poison is drawn into the round, altered, and rendered no longer an irritant to the nervous system. The same thing may be true of the altered, offending compounds of the blood; during these chemical changes they may be broken up and thrown off, or so altered as to be no longer excitants to the nervous systems. The nervous systems, when these offending compounds are removed, no longer excite the respiration and circulation. Another reason why nervous action may be diminished periodically, is found in the chemical changes going on in the nervous apparatus itself. If nervous force result from chemical change, and if the amount of nervous force corresponds to the chemical changes of a definite amount of matter placed in a definite position, then vigorous nervous action must always be attended by rapid alteration of the elements of the nervous system, and by a correspondingly rapid exhaustion of nervous force, and the action then would cease for the same reason that the action of an engine ceases when all the fuel is consumed. These views are substantiated by the fact, that in malarial fever a high temperature is almost invariably attended by a remission or intermission, and is a favorable symptom; whilst the want of a high temperature, as in congestive fever, is always a dangerous symptom, signifying profound alterations in the nervous system, and in the muscular structures of the heart.

The blood of this patient presented a dark, almost black color, which, upon the surface of the clot, changed to a bright red arterial hue after two hours' exposure to the atmosphere. The coagulation appeared to be a little slower than usual. The color of the serum was light golden. The color was not of the bright, deep golden yellow, which, as far as my experience extends, is the invariable color of the serum in the severer cases of malarial fever.

This patient had been sick but five or six days, and the fever was intermittent and of a mild type, and the changes of the blood were correspondingly small. The blood-corpuscles, and albumen, and fibrin were slightly diminished; the extractive and coloring matters were slightly increased, and the mineral matters were normal in amount.

The blood in No. 2 was abstracted from a thin, sallow, anemic French laborer, who had been living and working in a low miasmatic situation on Thunderbolt road, and had been sick with chill

and fever for five weeks, without any medical attendance. The effects of the miasmatic fever were well marked in the reduced flesh, feeble forces, sallow anemic complexion, and pale lips and gums, and in the neuralgic pains of the head.

The pulse and respiration during the intermissions were normal, whilst the respiration was slightly increased, and the temperature of the trunk and extremities slightly diminished.

The blood coagulated in the usual time, and the clot was firm. After standing four days in a stoppered bottle, in the heat of summer, the clot appeared firm, undecomposed, and the serum clear. The blood of a patient who was suffering from the effects of remittent fever and severe salivation, placed by the side of this, in the same time, and under the same circumstances, had its clot completely disintegrated, and commenced to putrefy.

This analysis confirms the statement that the malarial poison (either directly or indirectly) destroys the colored blood-corpuscles. They are diminished one half, the dried corpuscles being only 73.405, and the moist corpuscles 293.620; whilst in health the dried corpuscles generally average 135.000, and the moist corpuscles 540.000. The fibrin and mineral matters existed in the usual proportion.

The blood which furnished the analysis No. 3 was drawn from the arm of a thin, sallow, anemic Irish laborer, who had been living and making bricks in a low miasmatic situation, and had suffered with chill and fever for six weeks. Flesh reduced; complexion sallow, anemic; lips, gums, and tongue pale. This patient is exhausted by slight exertions, and complains of great weakness. Inferior extremities slightly œdematous. The pulse, respiration, and temperature were variable; sometimes above and at others below the normal temperature.

	Sept. 16th.	Sept. 17th.	Sept. 18th.	Sept. 19th.	Sept. 20th.
Pulse	88	72	72	76	96
Respiration	24	20	20	24	24
Temperature of atmosphere	87.5° F.	86° F.	88.0° F.	89° F.	83° F.
" of hand	100.5	90	98.5	98	100
" under tongue	101.25	98	99.5	99	102

The reduction of the nervous and physical forces was attended by a reduction in the solid constituents of the urine.

Thus, upon Sept. 17th, 16,027 grains of light-colored urine were

excreted during the twenty-hours, which contained only 68.432 grains of solid matters, composed of 42.681 grains of urea, 1.280 of uric acid, 18.776 grains of extractive and coloring matters, and 5.696 of mineral matters. Under the action of sulphate of quinia, and infusion of Virginia snakeroot, the solid matters of the urine increased rapidly in amount, and soon corresponded to the normal amount.

The blood of this patient was watery in appearance, and coagulated slowly.

Reaction decidedly alkaline.

After standing twenty hours the clot contracted but little, and it was soft, possessing but little consistency. In the specific gravity bottle the colored blood-corpuscles gravitated towards the bottom, and left above a transparent, light yellow clot.

Serum of a light yellow color.

This examination of the blood shows, that the continued action of the malarial poison had reduced the colored blood-corpuscles to 51.987 dried, or 207.948 moist, which is only a little more than one-third of the normal standard.

The fixed saline constituents of the colored blood-corpuscles were not only correspondingly, but absolutely diminished in amount, whilst the fixed saline constituents of the liquor sanguinis were normal in amount.

Notwithstanding the formation of the buffy coat, the fibrin was diminished, as well as the colored blood-corpuscles.

The blood in No. 4 was abstracted from the arm of a muscular, well-built English seaman, who had been exposed to the malarious influence when sleeping aboard his vessel, lying in the Altamaha river, opposite the town of Darien, and when running up and down the Savannah river, from its mouth to the city of Savannah, in a steam tug.

The fever was preceded by a chill, and was of the remittent type. The symptoms were indicative of great danger—tongue red, dry, harsh, and rough; skin hot, dry, and harsh; pulse accelerated; respiration panting, thoracic, and greatly accelerated; thirst intense; expression of countenance anxious; intellect dull and often wandering; urine high colored, concentrated, and rich in coloring matters and urea. The dry, red, glazed tongue; the dry skin; the panting, accelerated respiration, and the wandering intellect, were dangerous symptoms, indicating the decided action

of the poison upon the cerebro-spinal and sympathetic nervous systems, and upon the circulatory and respiratory apparatus. The elevated temperature, and high-colored urine, rich in solid matters, were, on the other hand, favorable symptoms, because they indicated the existence of chemical actions which would result in the modification of the malarial poison, and the destruction of the noxious compounds formed in the blood. The following table will illustrate the prominent symptoms:—

Date. 1857.	Hour of day.	State of Tongue, Skin, and Intellect.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Specific gravity of urine.	Urine excreted during 24 hrs.	Water excreted during 24 hrs.	Solid matters excreted during 24 hours.	Urea excreted during 24 hrs.	Uric acid for 24 hours.	Extractive and coloring matters excreted in 24 hours.	Fixed saline constituents in the urine excreted in 24 hours.
Sept. 10	7 P. M.	Tongue dry, red, superior portion coated with black fur; skin hot and dry; intellect dull.	90	48	80.1°	103.00°	105.°0	..	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
" 11	11 A. M.	Tongue dry, red, and glazed, feels rough; skin dry, harsh, and hot; intellect dull; countenance anxious.	88	34–40	82.0	103 25	105.0	1020.0	12240	11428	811	523	4.80	253	30
" 11	7 P. M.	Tongue—tip clean and red, superior portion coated with dark fur; skin moist and hot.	90	40–44	81.0	104.00	104.8	1019.6	15294	14294	999	669	4 35	270	54
" 12	12 M.	Tongue cleaner and moister, still red at tip and edges; skin moist.	70	26–36	83.0	100.75	102.5	1019.3	20383	19240	1142	790	7.45	185	158
" 12	9 P. M.	Tongue moist, still redder than normal.	70	53	83.0	99.16	101.5	1020.0	..	..	..	..	..	..	..
" 13	11 A. M.	Do do. do.	52	48	85.0	97.00	100 0	1024.0	..	..	..	..	..	..	..
" 13	6 P. M.	Tongue slightly coated with light yellow fur, soft and moist; skin normal.	60	26–32	..	..	..	1022.0	..	..	..	..	..	..	..
" 14	1 P. M.	Do. do. do.	58	28	87.0	99.00	102 0	1025.0	19418	..	..	679	10.79	..	45
" 15	10 A. M.	Do. do. do.	50	24	84.0	94.05	99.0	1016.5	8038	8584	452	267	5.07	147	31
" 15	7 P. M.	Do. do. do.	47	27	87.0	96.00	99.0	1018.2	13652	13186	465	140	16.66	252	55
" 16	12 M.	Do. do. do.	46	20–26	87.0	97.00	99.0	1022.2	6490	6057	432	212	3.79	169	46
" 16	8 P. M.	Do. do. do.	47	28	87.0	95.90	99.0	1020.0	9720	9238	481	203	8.95	214	53
" 17	11 A. M.	Do. do. do.	44	24	84.5	96.00	99.0	1018.0	13940	13023	916	197	9.11	449	258
" 18	12 M.	Do. do. do.	44	24	86 0	96.25	99 0	..	15903	..	..	..	..	..	..
" 19	12 M.	Do. do. do.	44	24	88.5	97.00	99.0	..	24240	..	..	..	..	..	..
" 20	12 M.	Do. do. do.	..	..	..	..	..	1010.0	32320	..	..	..	..	..	..
" 22	12 M.	Do. do. do.	44	22	84.0	97.08	99.12	1008.0	23300	..	..	..	..	..	..

The blood of this patient was abstracted upon the 16th day after the commencement of the attack of remittent fever, and during convalescence.

The blood coagulated in the usual time, and the clot was firm. During the coagulation, the blood-corpuscles settled, and left above a transparent clot, about $\frac{1}{8}$th of an inch in depth, and of a light yellow color. Color of serum, light yellow. This analysis shows that the dried organic residue, and especially the fixed saline constituents of the colored blood-corpuscles, have diminished.

The moist blood-corpuscles are less than the normal number, by near 100 parts in the 1000 parts of blood. The fixed saline constituents of the colored blood-corpuscles were less than one-half the normal amount.

This patient was treated with large doses of sulphate of quinia, stimulants, and nutritive diet; and this mode of treatment, combined with the vigorous chemical actions, as indicated by the high temperature, were, without doubt, the causes which preserved, to a great extent, the integrity of the blood.

The blood in No. 5 was abstracted from a young Scotch seaman, aged fourteen years, with light hair, blue eyes, florid complexion, and sanguine nervous temperament. This patient had been much exposed to the sun and the night air, upon the light-ship lying at the mouth of the Savannah River.

During the height of the fever the face was as red as scarlet; the tongue dry, red, and rough; tip and middle clean, and of a bright red color; posterior portion coated with dry yellow fur; surface as dry and harsh as a rough board; lay in a stupor, it was almost impossible to arouse him; manifested great tenderness of epigastrium; pressure here causes him to cry out. The following table will illustrate the condition of the pulse, respiration, temperature, skin, tongue, and intellect:—

Date.	Hour of day.	State of Tongue, Skin, and Intellect.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Specific gravity of urine.	Am't of urine excreted.	Characters of the Urine.
Sept. 16 1857,	7 P. M.	Skin of face as red as scarlet, skin of body in a profuse perspiration; tongue rough and perfectly dry; intellect in a stupor; cannot be aroused.	100	24	88.0°	102.00°	103.25°	Grs.	..	
" 17	11 A. M.	Skin and tongue moist and relaxed; intellect clear.	86	18	87.0	100.25	101.00	1008.2	12078	Light orange color.
" 18	12 M.	Tongue coated with yellow fur, much dryer than normal; intellect wandering.	98	32	87.5	103.00	104.00	1010.0	..	Light straw color; urea and uric acid diminished.
" 18	8 P. M.	Tongue bright red, dry, rough, and harsh; lies in a profound stupor.	90	26	85.0	102.25	103.25	..	..	
" 19	11 A. M.	Tongue moist, red at tip and edges, and coated with white fur; intellect bright.	..	..	..	..	..	1004.0	..	Light orange color.
" 20	12 M.	Tongue moist; intellect clear.	..	..	..	..	..	1001.0	30013	Light yellow color.
" 21	1 P. M.	Tongue moist and pale; intellect continues clear.	66	18	83.0	98.00	100.00	1006.0	10000	Deep orange color.
" 22	12 M.	Tongue, skin, and intellect normal.	65	18	84.5	98.00	99.50	1004.0	20800	Normal in color.
" 22	7 P. M.	.. ..	57	16	81.0	98.00	99.05	1003.0	21063	Light colored.

The pulse throughout was much feebler than in "healthy cases" of malarial fever. It is worthy of note, that the urine excreted during the delirious state was light colored, and of low specific gravity.

In this case, as in the preceding one, we cast aside the advice of many of the older writers, and administered the sulphate of quinia and stimulants freely in the first stages of the disease, regardless of the glowing parched tongue, tenderness upon pressure of the epigastrium, severe headache, high fever, rapid pulse, thoracic full respiration, hot, dry skin, and wandering intellect. Under the action of sulphate of quinia, cut cups, stimulants, and sinapisms, the dry, red tongue became moist, clean, and pale; the circulation and respiration abated in force and frequency, the dry, harsh skin was covered with perspiration, the intellect returned to its normal actions, and all the symptoms subsided.

In the present case, sinapisms, blisters, cut cups, and purgatives, diminished the apparant congestion of the brain temporarily, but not permanently. Stimulants and sulphate of quinia, so far from increasing the cerebral disturbance, diminished it permanently, and relieved the intellectual faculties. Under their action, the red, dry, rough tongue became pale, moist, and soft—under their action, the circulation and respiration were equalized, and diminished in fre-

quency; the temperature was diminished, and the intellect restored to its normal exercise.

The blood was drawn on the 10th day after the commencement of the malarial fever, during convalescence.

The clot appeared to be softer than normal.

Serum of a light yellow color.

The chemical examination of the blood showed that the organic matters of the colored blood-corpuscles were diminished slightly, whilst the mineral matters were greatly diminished. The fibrin was considerably below the normal standard, and appeared to be softer than normal. The organic matters of the serum were somewhat below the normal standard.

When we consider that this patient was in a state of almost complete starvation, during the height of the disease, it is evident that the malarial poison acted but slightly upon the constituents of the blood. The malarial poison appeared to act almost entirely upon the brain and nervous system. During the height of the disease, I had no hopes whatever of his recovery, so alarming were the cerebral symptoms. Long after the pulse and respiration, skin and digestive functions were restored to their normal actions, the patient was scarcely able to stand or walk, on account of the condition of the brain. His first efforts at walking resembled those of an infant, just learning to stand and walk alone. This was not due to the loss of muscular power, for there had been but a slight reduction of the size of the muscles. It was due rather to the disordered state of the cerebro-spinal and sympathetic nervous systems. The action of the malarial poison upon the brain and nervous system was, without doubt, greatly increased by peculiarities of constitution, irregularities of habit, and continued exposure to the hot sun on the light-ship.

I was afterwards informed that this boy was in the habit of using ardent spirits freely. It is probable that one or all these causes may have predisposed the brain and nervous systems to derangement, and interfered with the healthy action of the organs, and converted a light attack into a severe and dangerous disease.

It is probable that the dose of malaria was small, and aside from these circumstances, would have produced only a mild disease. We are led to this conclusion by the fact that its effects upon the blood and excretions were comparatively slight.

The blood marked No. 6 was drawn from the arm of an American seaman, six hours before death. This patient had been run-

ning up and down the Savannah River in a steam tug, and was attacked with chill and fever, which assumed the remittent type after four days' recurrence of the chill. During his sickness, the disease bore a blended likeness to both remittent and typhoid fevers, and after death the organs exhibited the existence simultaneously of both diseases.

The following table will give a condensed view of the symptoms:—

Date.	Hour of day.	State of Tongue, Skin, and Intellect.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
Aug. 7 1857.	11 A. M.	Skin hot, but in a profuse perspiration; tongue coated with light yellow fur; respiration hurried, thoracic; chest heaving; intellect stupid, torpid; it is difficult to arouse him, and then his answers are incoherent; bowels loose.	112	38	81.0°	103.0°	104°	Urine clear, limpid, and of a deep orange color.
" 8	9 A. M.	Skin hot and dry; continues stupid; bowels loose.	120	..	..	..	..	Urine reddish orange, sp. gr. 1013; 1000 parts contained—water 957.282, solid matters 42.618, urea 7.108, uric acid 0.394, extractive and coloring matters 32.570, fixed salts 2.621.
" 8	11 A. M.	Skin moist; body has a peculiar offensive smell; breath offensive; stools very offensive; intellect stupid; low muttering delirium.	112	36	80.0	103.0	104	
" 9	11 A. M.	All symptoms much worse; passes his urine and feces in bed; has a pustular eruption over the surface of the trunk and limbs; surface of blister red and raw; the stools dark colored and fetid.	112	40	80.0	103.5	..	Urine of a bright reddish-brown color, cloudy, with epithelial cells from the mucous membrane, bladder and urethra, and with mucous corpuscles and spermatozoa.
" 9	6 P. M.	No improvement of symptoms; tongue dry; blister dry and red; bowels loose; skin not so warm; pulse weaker.	104	..	..	..	..	
" 10	9 A. M.	Continues to grow worse.	..	..	..	..	..	Urine of a bright red color, sp. gr. 1012.6; contains albumen; reaction strongly acid.
" 10	11 A. M.	Do. do.	120	40	..	..	..	Urine bright red color; after standing 12 hours, a heavy deposit of triple phosphate fell; contains albumen.
" 11	10 A. M.	Almost entirely insensible; lies with mouth and eyes open; his elbows, shoulders, and hips, upon which the weight of his body has rested, are of a dark purple color, and the skin is commencing to slough at those parts most exposed; tongue dry and rough; teeth coated with sordes.	132	47	80.0	104.0	105	Urine a shade higher than normal; reaction acid; sp. gr. 1013.2; after 12 hours, let fall a light yellow deposit of triple phosphate, urate of soda, and spermatozoa; 1000 parts contained—water 961.112, solid matters 38.888, urea 12.304, uric acid 0.592, extractive and color'g matters 22.259, fixed saline constituents 3.333.
" 12	8½	Died.	..	..	..	..	..	Urine, passed just before death, normal in color; sp. gr. 1011.3; reaction acid; 1000 parts contained—water 972.728, solid matters 27.272, urea 5.228, uric acid 0.158, extractive and color'g matters 18.543, fixed saline constituents 3.030.

The body was examined four hours after death. The exterior was of a universal sallow color.

The muscles were full and well-developed, and appeared to have lost but little flesh during the progress of the disease.

The membranes of the brain presented a normal appearance, and the substance was firm, and not more congested with blood than normal.

The appearance of the structure and condition of the brain, and its bloodvessels, and membranes, did not correspond to the condition of softening which the cerebral symptoms led us to expect.

The brain was not examined microscopically, and there may have been minute changes in the delicate structures, chemical or physical, which escaped the observation of the naked eye. This is possible, but not probable. It is hardly probable that profound alterations could take place in so delicate an organ as the brain, without some changes in its color or consistence, palpable to the naked eye.

Heart and lungs normal.

The liver presented the true malarial hue; slate-colored upon the exterior, and dark bronze in the interior.

The bile was of a greenish-black opaque color when seen in mass, and of a gamboge-yellow color when spread out in thin layers. The structures of the liver presented the usual consistence. The liver-cells, under the microscope, appeared to be a shade darker than usual; but presented the usual shape and appearance.

No trace of grape-sugar was discovered in the liver. The blood of the liver was dark, and did not change to the arterial hue when exposed to the oxygen of the atmosphere.

The filtered decoction of the liver presented a bright golden color, similar in all respects to the color of the serum of the blood.

The spleen was slate-colored, enlarged, and softened. The tissues gave way readily under gentle pressure. The dark, reddish-brown pulp of the spleen consisted of numerous colored and colorless corpuscles, and did not change to the arterial hue when exposed to the oxygen of the atmosphere.

The mucous membrane of the stomach was colored yellow with bile, and the bloodvessels were filled with blood, and several spots of the mucous membrane were more engorged with blood than the rest of the surface; but to the naked eye there was no softening or

marks of inflammation, and no pathological alterations beyond the mere stasis of the blood in the capillaries.

The color of the intestines, externally and internally, was darker than usual. The small intestines contained fecal matters, epithelial cells, mucous corpuscles, and mucus colored yellow by bile. Bloodvessels of the mucous membrane of the small and large intestines injected with blood. The mucous membrane was most injected with blood, and presented a purplish color in the last eight feet of the inferior portion of the ileum, and the engorgement of the bloodvessels was greatest in the immediate region of the ileo-cæcal valve.

The solitary glands were numerous, enlarged, elevated, and distinct, and of a brown color. When the intestines were held up to the light, bloodvessels engorged with blood were seen passing to each gland. The bloodvessels supplying the solitary and Peyer's glands were more engorged with blood than those supplying the mucous membrane generally. These solitary glands were most numerous in the neighborhood of the ileo-cæcal valve, and were found scattered over the superior portion of the colon, and over the cæcum, and over eight feet of the inferior portion of the ileum.

Peyer's glands were enlarged and elevated. These glands were of various sizes, from one quarter of an inch to three inches in length, and from a quarter of an inch to half an inch in breadth. They occurred at intervals of from one to two inches from each other, and extended from the ileo-cæcal valve, along the mucous membrane of the ileum, for about nine feet. The bloodvessels around these glands were engorged with blood. This part of the mucous membrane of the ileum, studied with the solitary and Peyer's glands, was far more injected with blood than the stomach, jejunum, or superior portion of the ileum. Although these glands were enlarged, elevated, and injected with blood, still they could not by any means be compared to the condition of these glands in an advanced stage of typhoid fever.

From this examination we are now able to present a condensed statement of the prominent symptoms and alterations of the solids and fluids.

The pulse was feeble, and varied from 104 to 132 beats in the minute; the respiration was hurried, thoracic, and varied from 36 to 47 in the minute; the temperature under the tongue varied from 104° F. to 105°; the temperature of the extremities varied from 103° to 104°; the temperature of both the trunk and extremities

was remarkably uniform; the state of the skin varied, sometimes dry, and at others bathed in perspiration; the tongue was dry and coated with fur; and towards the termination of the disease, the tongue and teeth were coated with sordes. It is evident from these facts that there was no distinct remission of the febrile excitement.

The urine was copious; of low specific gravity; of higher color than normal in the earlier stages of the disease; but twenty hours before death it changed back to its normal color. The urine contained small quantities of albumen. The urea was diminished relatively to the extractive matters; we cannot say absolutely, because the whole amount of urine excreted was not determined. The extractive matters were increased relatively to the other constituents of the urine. The uric acid was normal in amount.

The blood exhibited profound alterations; the dried colored corpuscles were only 65.612, and the moist colored corpuscles 262.448, in the thousand parts; many of the colored corpuscles were altered in shape and appearance, and had in a great measure lost the power of changing from the venous to the arterial color, and many of them united together and formed rolls, as in the blood of inflammation; the color of the venous blood, when first abstracted, was dark purple, almost purple, and after exposure to the oxygen of the atmosphere the surface of the clot changed to a cherry-red color, and not to the bright red color assumed by the surface of healthy venous blood when exposed to the atmosphere; the serum was of a golden color, and low specific gravity; the albumen was diminished, whilst the extractive matters of the serum were increased; the mineral matters of both the blood-corpuscles and liquor sanguinis were diminished relatively, but not absolutely; that is, their diminution corresponded with, but did not exceed the diminution of the other elements of the blood.

The pustular eruption, the offensive smell, the stasis of the blood in the parts of the body exposed to pressure, and the tendency of these parts to slough, all indicated alterations in the constitution of the blood, and derangement of the capillary circulation.

The loss of muscular power, exhaustion, stupidity, coma, low muttering delirium, insensibility to pain, all indicated derangement of the cerebro-spinal system.

The alterations in the actions of the capillary and general circulations, and of the respiration; the profound alterations in the blood; the alterations of the secretions and excretions, and of the structures of the liver and spleen, and of Peyer's, and of the soli-

tary glands of the intestines, were all indicative of derangements of the sympathetic system of nerves.

Our knowledge of the early symptoms, and pathological changes of this case, do not permit an arbitrary decision as to which system of nerves was affected primarily. The fact that the *post-mortem* examination revealed (to the naked eye) no prominent lesions of these two systems of nerves, would seem to indicate that the poison or poisons acted primarily upon the blood, destroying and altering the blood-corpuscles, the active agents in the elaboration of the elements of the secretions, and of the muscular and nervous systems. When the proper chemical changes in the blood were altered, when the compounds for the secretions and nutrition of the nervous system were altered, or not elaborated, then both the cerebro-spinal and sympathetic systems, manifested aberrated action. As the circulation and respiration, and the secretions and excretions, and the action and integrity of the organs depend, in great measure, upon the integrity of the nervous system, it is evident that the derangement of the cerebro-spinal and sympathetic systems, through the derangement of the blood and secretions and excretions, would in turn act in concert with the disturbing agent or agents, and thus still greater derangements of the solids and fluids would be produced.

The opinion of Hoffmann, Boerhaave, Cullen, Selle, Tode, Thorer, Stoll, J. C. Frank, Foderé, Clutterbuck, Alibert, Rayer, Nepple, and others, which referred fevers to a lesion of the nervous system, was adopted and extensively applied by Maillot,[1] in his original, elaborate, and invaluable work on malarial fever. M. Maillot looked upon the cerebro-spinal axis as the point of departure of the series of morbid actions constituting periodical fever, and affirmed that an acute irritation or hyperæmia of the great nervous centres existed during the active stages of malarial fever. In this country, my colleagues, Professors Lewis D. Ford[2] and L. A.

[1] Traité des Fièvres ou Irritations Cérébro-Spinales Intermittentes d'Apres des Observations recueillies en France, en Corse, et en Afrique. Par F. C. Maillot. Paris, 1836.

[2] "It thus appears that of these forty cases of intermitting and remitting fever, this tenderness on pressure of some portion of the spinal column was present in all but four cases of remitting fever, and in two cases of intermittent; of these, however, one was arrested by a blister to the spine, without other means used but dieting, and the other was modified materially in its character in like manner." * * *—p. 354.

"Another question naturally presents itself: What is the force and value of this

Dugas,[1] simultaneously with the appearance of the work of Maillot, maintained that the phenomena of intermitting and remitting fevers

symptom? whence this uneasiness? what does its existence indicate? Certainly not that the skin at these particular points is sore and tender. I have examined carefully, to verify this fact, by taking it up between the thumb and finger, and compressing it with more force than was applied by the direct pressure; uniformly receiving the assurance of the patient that the uneasiness was of a different character from that produced by pressure upon the bone. But if this might be the cause of pain in the method by pressure, it cannot be in that by percussion; for it is well known to those who make use of mediate percussion that it may be employed freely even upon a blistered surface, without producing pain. It as certainly does not indicate that the *bone itself* is tender and diseased; for we cannot conceive why pressure upon a diseased bone should be followed by sighing, coughing, increased oppression of the præcordia, nausea, and faintness. It is as unsatisfactory, for the same reasons, to attribute this symptom directly to a diseased state of the ligaments of the vertebræ.

"Having thus excluded these three parts from any participation in the production of this phenomenon, we next inquire, Can it proceed from a diseased state of the dura mater lining the bony channel? We answer unhesitatingly that the symptoms above referred to, developed in distant organs by the examination, cannot arise directly from an inflammation or any degree of irritation of the dura mater, for reasons assigned already; but we can conceive very readily how the dura mater, being in a swollen state, might produce such symptoms by compressing the origin of nerves supplying these distant organs when an unusual degree of motion is communicated to the vertebræ by percussion. But we perceive that this unusual motion of the vertebra would produce the same degree of pressure if the dura mater were in its normal state, and the substance of the cord itself enlarged. We therefore must necessarily adopt the conclusion that this phenomenon indicates a diseased state either of the medullary substance of the spinal cord, or of its investing membranes. I am not prepared to infer from these few cases that this local affection of the spine always exists, nor that it is the primary irritation upon which these fevers depend; but if subsequent observations shall establish the uniform existence of this spinal irritation at the commencement of intermitting and remitting fevers, it will confirm the opinion, now almost universally held by the profession, of the local origin of all fevers, and the equally universal persuasion that this location is in some part of the nervous system."—pp. 357–359.*

[1] "When, fresh from the benches of the school of organic medicine, I was called on to examine and to treat cases of 'bilious fever,' I instinctively interrogated in succession every organ of the body, in search of the seat of the disease, or, in other words, of the cause of so much constitutional disturbance. In some cases, despite all my investigations, no trace of disordered function (the best evidence of a diseased organ) could be detected elsewhere than in the stomach; in others the bowels were alone distempered; other sets evinced the disturbance to be located in the liver, in the brain, or in more than one of the principal viscera. The bilious modification implied by the name of the affection, though very frequently manifest,

* Remarks on the Pathology and Treatment of Intermittent and Remittent Fevers, with Cases. By Lewis D. Ford, M. D., Professor of Chemistry in the Medical College of Georgia. Southern Medical and Surgical Journal, vol. i. No. 6, November, 1836, pp. 335–360.

depend upon lesions of the cerebro-spinal nervous system; and, at the present day, my colleague, Professor Henry F. Camp-

was often entirely wanting. Yet each of these cases presented certain characters peculiar to all. Their onset was always marked by loss of muscular power, by pains in various parts of the muscular system of animal life, &c.; their early stage by intermittency, or decided remissions; their duration and termination presented a strong analogy; in short, it was evident that although modified by the affection of some special organ, all these cases were under the predominance of an original and common affection. The seat of this original and common affection cannot be mistaken if we adhere to the principle already alluded to, that of regarding vitiated function as the best indication of diseased organs. If an organ be healthy, its function must necessarily be normal; consequently, if a function be abnormal, the organ presiding over it cannot be in a physiological condition. I am aware that it will be urged that certain secretions may be vitiated by an altered condition of the fluid whence they are derived, without disease of the secerning organs. For example, the urine may present various aspects, according to the substances taken into the circulation, or the composition of the bile may depend on that of the blood. But this cannot affect our position, for the condition of the blood itself depends entirely on that of the organs which form it, and of those whose office it is to eliminate its impurities. If it remains impure, the cause must be found in the vitiated action of the emunctories.

"But, whether these principles of diagnosis be admitted or not, it is presumed that no one would, on reflection, refer the morbid condition of the contractility and sensibility of the muscular system to any other locality than the nervous centres. We have already stated the earliest symptoms of our fevers to be lassitude, loss of muscular power, and pains in the muscles of animal life; also, that intermittency, more or less complete, always marks their early stage. We are, therefore, led to the conclusion that the nervous system is the *original and common seat* of this class of affections. I trust that I will not be misunderstood; the term *original* being here used expressly to indicate that these fevers *subsequently* undergo serious modifications, from the supervention of other derangements. It is to these complications we must look for the explanation of the various forms assumed by the fevers misnamed *bilious*, so that the proper definition of them should be *an original affection of the nervous centres, subsequently complicated by phlogosis of some other organ or organs, which secondary disorder may either gain the ascendency of the primary, or merely mask and modify it.*" * * *—pp. 388, 389.

"We have already stated that neither of the above complicating phlegmasiæ, alone or *unattended with spinal disease*, could produce the phenomena common to all the forms of our 'bilious fevers,' and we have furthermore stated the primary lesion to be that of the nervous centre, or, in other words, of the spinal cord. If the primary affection remain uncomplicated, then we have a disease of the mildest form known, one which retains its peculiar characteristics, its paroxysmal form, and its periodicity. In short, we have a plain case of ague and fever, such as we daily see." * * *—p. 393.

"The action of quinine will always be most happily seconded by revulsive applications to the spine, which is frequently found painful on pressure or percussion. Indeed these will alone, in many instances, be found sufficient to arrest the disease. For evidence of this very decided effect I would refer to the interesting and able

bell,[1] advocates a similar theory. On the other hand, Professor John Fred. Lobstein[2] and James Copland[3] have ably and elaborately advocated the more probable theory that the malarial poison affects primarily and especially the sympathetic nervous system.

paper published by Professor Ford in the sixth number of the *Southern Medical and Surgical Journal.*"—p. 394.*

[1] "As in the nervous system we recognize two grand departments—viz., 1st, the cerebro-spinal system, all the normal actions of which are subject to cessations and interruptions; and, 2dly, the ganglionic system, all the normal actions of which are of a continuous and uninterrupted character—so in the manifestations of febrile diseases do we distinctly recognize two grand distinguishing characteristics respectively typefying the normal actions of these two systems of nerves; thus a character of paroxysm obtains in certain cases, while a character of continuousness as plainly marks the others. Again, as in the cerebro-spinal system we find that its normal action pertains almost exclusively to sensation and to motion, with only a secondary and comparatively somewhat remote influence (which we have termed excito-secretory) upon nutrition and secretion, while in the normal action of the ganglionic system the entire function is known to be to preside over nutrition and the secretions, so in *paroxysmal fevers* do we find intense pain, modified sensation, and symptoms allying them to neuralgic and convulsive diseases very prominent, while in continued fevers modified nutrition and altered secretion are the marked and most prominent characteristics. We would therefore announce, as our classification of febrile diseases, two grand divisions of fevers corresponding with the two grand divisions of the nervous system, thus:—

"1. Cerebro-spinal fevers. All *paroxysmal.* The secretions and nutrition secondarily affected.

"2. Ganglionic fevers. All *continued.* The secretions and nutrition primarily affected.

"Under the head of cerebro-spinal fevers we would place the whole family of paroxysmal fevers, whatever type they may assume, and also the various forms of neuralgia, which are nearly always intermittent, as well as the sthenic forms of traumatic fever, together with the fever accompanying simple pharyngitis, pneumonitis, dysentery, and many other diseases of malarious districts."†

The late Dr. Milton Antony published, in the year 1837, an interesting article upon spinal irritation, from which we select the following passages:—

"Because spinal irritation is, indeed, the true cause of the most conspicuous phenomena, as is evident on the soundest principles of physiology, and proved by their correction by its removal, it so captivated the thoughts, not sufficiently chastised by time and experience, as (although itself an effect) to be considered the primary and efficient cause of all, to the neglect of all concomitant or antecedent phenomena, and even its own etiology. Inquiry, I say, stops here at the

* Remarks on the Pathology and Treatment of Bilious Fever. Read before the Medical Society of Augusta, by L. A. Dugas, M. D., Professor of Anatomy in the Medical College of Georgia. Southern Medical and Surgical Journal, vol. ii. No. 7, February, 1838, pp. 387–397.

† Classification of Febrile Diseases by their Relation to the Nervous System. By Henry F. Campbell, M. D., Professor of Anatomy in the Medical College of Georgia. Southern Medical and Surgical Journal, vol. xiv. No. 1, January, 1858, pp. 13–18. See also Transactions of the American Medical Association, 1858.

detection of the fact of spinal irritation, satisfied that here is the real, here the first, independent, and sole cause. The indication of its removal, and that alone, is, therefore, plainly drawn from the premises. And so strongly does the spell hold its sway over the rational mind that, although *no evidence of the fact* of spinal irritation can be apprehended, it is still believed so intimately connected with the other phenomena in relation of cause as to have its existence inferred from these.

"Here are the errors I would expose. * * * To the inquiring mind I say this local phenomenon, so clearly and beautifully displayed, cannot fail to reveal another truth. Could this spinal irritation have occurred without having its own peculiar and appropriate cause? Certainly not, as there is no effect without competent causation. If, then, it have a cause, is it abiding? Or has it been momentary, and, therefore, left only its *effects* to be corrected? If the former, surely nothing can justify the neglect of such abiding cause of any train of phenomena when our object is the removal of that train. As well might we expect to heal a wound whilst the thorn which caused it continues to rankle there. Our experience justifies the belief that spinal irritation generally, though not always, is dependent upon an abiding cause, for we have often detected such cases and removed them, correcting thereby their effects without any prescription for these." * * *—pp. 581, 582.

"We find an intermitting fever attended with some degree of irritation about the spinal marrow. As spinal irritation seldom, if ever, exists idiopathically, shall we not rather look to it as an index pointing to other disorder? In this case an inquiry is necessary into the pathological condition of the general system, or the various organs, under the existence of an intermitting fever. And here we find that the liver and the spleen sometimes are laboring under an obstructing torpor, which prevents that free transmission of blood through them which the great portal system demands. This is a fact that we know to exist; and if we did not, it is susceptible of plain proof.

"Now, suppose a given quantity of blood in the system at the moment of consideration as twenty-four pounds, and that one-twelfth, or two pounds, passes the portal system, whilst the other twenty-two do the other circulation. The abdominal fulness evinces the obstruction. If, now, we allow any obstructing cause in the route of the portal circulation, the liver is the only organ where we may suppose it located. Let us suppose that this obstruction is such as to transmit only half the quantity of blood in a given time. The unavoidable consequence and proximate effect of this must be an increased fulness of the portal vessels. This accomplished to its utmost, and the next consequent must be their refusal to imbibe or receive more than half their natural quantity in a given time, or one instead of two pounds, and consequently, if the health were perfect in the former state, there is, to say nothing about the quantity of blood, a redundance of about four per cent. Following this inquiry, we perceive, therefore, local phenomena, and especially in non-resisting parts, and consequently a cause of irritation or of oppression." * * *—p. 585.

"In all these cases, therefore, we are bound to direct attention to the first seat of the obstruction and irritation. Let the partisan in medical doctrines have his choice of the horns of the dilemma, still is he bound to look to it as a cause, whether it be the local irritation alone acting through the medium of the nerves, or merely the effect of the sanguine plethora, already prescribed. And in case of the combination of both, he must look to the removal of the obstruction to circula-

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tion, as well as the subduction of irritation in the primarily obstructed and irritated part."*—p. 586.

[2] "In reflecting upon the nature of intermittent fevers, I have thought that it might, perhaps, be found in the disorder and perverted action of the abdominal nervous system, and there appear, indeed, to be sufficient grounds to render this opinion probable: 1st. The cases of this disease are very rare in which the functions of the abdominal organs continue vigorous and entirely unaffected. 2d. The commencement of the paroxysms is often marked with vomiting. 3d. We experience daily that this disease is mitigated, and very often entirely removed, by the use of cathartics. 4th. A single emetic, when given previously, sometimes suppresses the paroxysm, and not unusually removes the whole disease; from which it appears that this remedy makes an impression upon the solar plexus of an opposite nature to that which had produced the fever. 5th. When the disease is either left to itself or maltreated, congestions are produced in the abdominal viscera, induration of the liver, intumescence of the spleen, etc., and the general morbid state is changed into a topical affection. This metamorphosis appears to me to prove that the morbid action prevails at first in all the plexuses, and afterwards migrates from one to another; for it is first apparently disseminated in the whole territory of the ganglionic system before it runs with impetus into a single plexus, which is commonly the splenic; and as the vessels are under the influence of the nerves, it cannot be otherwise than that congestions should thus be produced in the vessels. 6th. The paroxysms of intermittent fever are tied down to a regular rhythmus, in consequence of their being radicated in the nervous system, upon which nature has impressed a law according to which they must perform their functions periodically.

"Each nervous system, therefore, is obnoxious to its own diseases. But the mode in which the cerebral and spinal nerves and the nerves of the abdominal plexuses and ganglia are affected by disease is the same. As in the various kinds of convulsions, epilepsy, tetanus, etc., there is disorder in the voluntary nerves, even when no organic lesion can be discovered in them; so the nerves of the thoracic and abdominal viscera may be affected without any alteration perceptible to the senses. As the perverted action of the cephalic brain is reflected with great force upon the abdominal brain, so, in turn, does the latter react upon and overwhelm the former. And, finally, as the cerebral system, when it is stupefied, as it were, by the violence of disease, destroys life, in like manner, I believe, an analogous effect takes place in certain diseases in the solar plexus."†

[3] The articles on Fevers in Dr. Copland's *Medical Dictionary* are the most elaborate, learned, and philosophical with which I am acquainted, and correspond with the other articles in his gigantic work, which will ever stand a noble monument of industry, energy, perseverance, learning, and philosophy. The following quotations will present a bare outline of his views:—

"The doctrine that *the causes of fever first affect the cerebro-spinal nervous system* is invalidated by the following considerations: *a*. This system either does not send nerves or it supplies but few nerves, and those often indirectly, to the organs especially or essentially affected in idiopathic fevers, as the heart, bloodvessels, secreting viscera, lungs, &c. *b*. That the chief avenues to this system open to the invasion of the exciting causes are the organs of sense and the cutaneous surface.

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* Remarks on Spinal Irritation, by M. Antony, M. D., Professor of Obstetrics in the Medical College of Georgia. Southern Medical and Surgical Journal, vol. i. Nos. 9 and 10, March, 1837, pp. 580–587.

† A Treatise on the Structure, Functions, and Diseases of the Human Sympathetic Nerve, by John Fred. Lobstein. Translated by Joseph Pancoast, M. D. Philadelphia, 1831, pp. 121, 122.

Of these, the sense of smell is the principal. Although this sense is evidently impressed by several of these causes when acting intensely, and admitting that the brain is somewhat affected in consequence, still the effect produced in this quarter seems inadequate to explain the chief, and far less the whole, of the early phenomena. *c.* In some instances the intense operation of the effluvia generating fever has produced its effects almost instantly, and even caused death itself with equal rapidity, a result which the total annihilation of the cerebral functions could not produce, but which would necessarily follow the interruption or suppression of the influence transmitted to the heart and lungs by the nervous system of organic life. *d.* The generation of fever within the body itself cannot be explained upon the supposition that the cerebro-spinal nervous system is primarily and solely, or even chiefly, concerned in the production of the disease, but may be readily solved by means of the nervous system of organic life, if we take into consideration its functions and structural relations, especially with the vascular system, the circulating fluids, and the excreting viscera. *e.* The early lesions, whether of function or of organization, characterizing the first as well as the advanced periods of fever, cannot be accounted for by assigning the cerebro-spinal nervous system as the primary seat of the disease; for, 1st. As this system cannot influence the action of the heart and the state of the vessels, excepting through the medium of the organic nervous system, and this only to a very limited extent, changes in it do not explain the alterations of vascular action, and still less the vitiation of the blood. 2d. As it does not control animal heat, so it cannot induce those remarkable extremes and morbid states of temperature distinguishing the malady. 3d. As it does not supply nor materially influence secreting surfaces and glands, so it cannot give rise to those early changes of function which they present, nor to those lesions of structure which they often subsequently experience. 4th. As it does not materially affect the actions of assimilation and nutrition, so it cannot occasion the remarkable changes they present in fevers. And, 5th. As it does not present aberrations of function, in the slighter and simpler states of fever, equal in degree to those manifested by the viscera, chiefly supplied by the nerves of organic life; and as, when such aberrations supervene in a remarkable manner, they are generally consequent upon those of the organic nerves and vascular systems, and of the blood itself, so that the primary impression made upon it must be much less energetic than is supposed by those who support the present doctrine, although I may grant that it partakes, in some measure, or in some forms of fever, of the morbid impression especially and principally made upon the nervous system of organic life, and extended to the organs which it actuates."

"*That the efficient agents of fever act primarily and chiefly upon the organic or ganglionic nervous system* is evident from what has been now adduced, and is farther proved by the following facts and inferences: *a.* The intimate connection of this system with the organs of circulation, respiration, assimilation, and secretion, on the one hand, and with the cerebro-spinal nervous system on the other, and the influence exerted by it over their functions in health, are sufficient to show that morbid impressions made upon it must necessarily affect all the organs and parts with which it is related. *b.* The functions primarily disordered in fever, and chiefly affected in its course, are precisely those which are especially subjected to the influence of this system. As we cannot, consistently with our knowledge of the animal actions in health and in disease, infer that a grave and permanent disorder of any one function can exist, unless either the influence that actuates it is impaired, excited, or otherwise altered, or the structure of the organ, which is the instrument of the function, is more or less affected; we are necessarily led to

Still a fourth theory may be advanced to account for the changes; that the poison or poisons acted primarily upon one or both the grand portions of the nervous systems, and the cerebro-spinal and sympathetic systems, singly or combined, in turn altered the actions of the organs and apparatus, and the secretions and excretions, and chemical and physical actions over which they presided.

We will discuss these questions more fully hereafter, when we consider the nervous phenomena.

Before, however, dismissing the subject, we would state that in the present state of medical science, we cannot decide dogmatically upon the truth of these theories, because the ultimate facts are wanting.

What is the poison or poisons which we have assumed to exist, and act upon the organs and tissues, and solids and fluids?

What is the relation of these substances, physically, chemically, physiologically and pathologically to the cerebro-spinal and sympathetic systems, to the blood-corpuscles and elements of the blood, organic and mineral, and to the organs, tissues, and secretions and excretions?

In other words, what physical, chemical, physiological and pathological changes, are they capable of producing in the solids and fluids of the human body, and what effects would these changes have upon the development and action of the vital and nervous forces?

inquire as to which of these sources the disorder is to be imputed. Having inferred from the nature and extent of the disorder, from the causes in which it arose, and the suddenness and manner of its occurrence, as well as from various other circumstances, that it does not consist of lesion of structure, we are, therefore, compelled to adopt the former alternative, and, from the kind of disorder, to infer the manner in which the influence actuating the organ is affected. Thus, observing that respiration, circulation, secretion, and animal heat are primarily and especially disordered at the commencement of fever, and that various other morbid phenomena are consequently produced, and finding no structural or local change to account for the affection, we refer it to the state of the influence which actuates these functions. Anatomical and physiological evidence concur in showing that the nervous system of organic life is chiefly concerned in the production of those functions; and, therefore, it may be inferred that this system is first impressed by the causes of the disease."*

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* A Dictionary of Practical Medicine, comprising General Pathology, the Nature and Treatment of Diseases, Morbid Structures, and the Disorders especially incident to Climates, to the Sex, and to the different Epochs of Life, &c., by James Copland, M. D., F. R. S., &c. Edited with additions by Charles A. Lee, A. M., M. D., &c., in three volumes. New York, Harper & Brothers, 1855. Vol. I., article Fever, pp. 1064, 1065; also pp. 1038–1084. Intermittent fever, pp. 1085–1100. Remittent fever, pp 1100–1122. Hectic, Continued, Inflammatory, Bilo-gastric, Synchoid, Typhoid, and Typhus fevers, pp. 1123–1230. Article Disease, pp. 641–689.

Until these questions are definitely answered, our opinions must be speculative, and not absolute, and the results of our analogical reasoning must be expressed as hypotheses and not as laws.

The destruction of the colored corpuscles; the golden color of the serum; the slate color of the liver upon the exterior, and bronzed color in the interior; the color of the bile; the absence of grape-sugar from the structures of the liver; the slate color of the spleen, and the disorganized state of its tissues, and the inability of its pulp to change from the dark reddish-brown to the arterial color, gave decided evidence that this was a case of malarial fever.

There were, however, other symptoms and other lesions, which indicated that there was something besides malarial fever. The cerebral and nervous symptoms; the continued febrile excitement without intermission; the loose state of the bowels; the unusual action of a small dose of castor oil; the enlarged and congested glands of Peyer, and solitary glands of the intestines, indicated the presence of typhoid fever. The history of the case (the recent attack of remittent fever), and the fact that the glands of Peyer showed the marks of recent, only partially developed inflammation, and pathological changes, and not the changes produced by typhoid fever of long standing, lead us to the conclusion that the remittent fever preceded, or was, at least, simultaneous with the appearance of the typhoid fever.

The blood in No. 7 was abstracted from an Irish laborer, who had been reduced by an attack of remittent fever, diarrhœa, and salivation, from 200 pounds to 100. At the time of this analysis, he was suffering with foul ulcers in his mouth, and over the surface of the body, especially upon the back; and his body had a most disgusting nauseous smell. Complexion sallow and anemic; and forces completely worn out with pain and loss of sleep.

Blood coagulated slowly. In the specific-gravity bottle, the colored corpuscles settled to the bottom, leaving above a clear golden-yellow clot.

In a small, shallow porcelain capsule, the superior central portions of the clot appeared transparent for several lines in depth. A portion of the blood was set aside in a glass vessel. In twelve hours the clot commenced to disintegrate and liberate its colored blood-corpuscles, and in twenty-four hours the blood gave forth a putrid smell, and the serum was filled with the liberated colored corpuscles presenting the appearance of blood. A specimen of blood drawn at the same time from a patient who had recovered

from an attack of intermittent fever three weeks before, was placed in the same room, in a similar bottle, by the side of this specimen. The clot, serum, and odor of this remained unaltered for fifty hours.

Serum of a golden-yellow color. The colored blood-corpuscles were diminished nearly one-half, and the fibrin was slightly increased. The golden color of the serum, and the foul ulcers, and the readiness with which the blood underwent putrefaction, all pointed to alterations in the constituents of the blood and nutritive fluids. Stimulants, tonics, and alteratives produced but little apparent effect.

The patient continued dull, stupid, anxious, distressed, and feeble. His body continued to exhale the disgusting stench.

Four days after bleeding, his left arm swelled enormously.

Eleven days after the abstraction of the blood, he took a sudden and remarkable change for the worse.

Lay in a stupor, with mouth and eyes open, with every tendon and muscle of his body twitching and jumping violently. Respiration 42, labored, thoracic, spasmodic like that of a man during a severe chill. At every inspiration and expiration, emits a sound like the hoarse bark of a thirsty and starved dog. The muscles of the face contract and relax, and contort in every possible manner, making the most awful grimaces. During these contortions of the muscles of the face, every expression of ridicule, sarcasm, joy, pain, agony, malice, revenge, and hatred, are depicted in rapid succession. The jerking of the muscles appear to be paroxysmal; they are very violent for a few moments, and then moderate for a few moments. The patients in this large hospital ward, state that they were kept awake during the whole night, by his barking and shaking. Pulse 144, feeble. It was very difficult to count the beats of the pulse, on account of the violent twitchings of the tendons of the forearm. Temperature of trunk and extremities, several degrees above the normal standard. Skin covered with clammy sweat, which resembles bloody serum, and stains his clothes and bed just as bloody serum would do. Odor of his body intolerable. Passes his feces and urine in bed. This patient continued in this condition for three days, and finally died. Unfortunately, no *post-mortem* examination was performed, on account of the earnest entreaties of his superstitious friends.

This second attack was, in all probability, either a relapse, or a fresh attack of malarial fever.

This case illustrates in a forcible manner the effects of the ma-

larial poison in altering the constitution of the blood, and of the organs and tissues, and in causing aberration of the muscular and nervous, and physical and vital forces.

The blood in No. 8 was drawn from the arm of a German butcher, who had suffered for two months with chill and fever, without any medical attendance, and who entered the hospital in a comatose condition, reduced in flesh from 180 pounds to 110 pounds, with feeble forces.

Complexion sallow, anemic; nervous and muscular forces very feeble. Pulse 120, feeble. Respiration 24, labored. Tongue perfectly dry, and rough. Skin dry and rough over all parts of the body. Although revived and partially relieved by sinapisms, stimulants, and sulphate of quinia, the malarial poison had induced such profound alterations in the blood and organs, that the effects were followed by the most distressing suffering, and finally death.

The blood drawn shortly after his entrance into the hospital, whilst he was in this comatose condition, coagulated rather slowly. In one specimen, the coagulation was remarkably slow, and the blood-corpuscles gravitated towards the bottom of the vessel, and left above a clear, golden-colored clot. The transparent portion of the clot was about one-fourth of an inch in thickness. Serum of a deep golden color, reaction alkaline.

The fibrin was greatly deficient. The deficiency of the fibrin in the blood was further demonstrated by the fact that the blood oozed from the cut-cups upon the temples for eighteen hours, and it was finally necessary to check the flow by cold affusions.

The colored blood-corpuscles were greatly diminished; the dried corpuscles being 79.434, and the moist corpuscles 317.748. The fixed saline constituents were correspondingly reduced in amount. The albumen was also diminished.

It is worthy of note that, in the different forms of malarial fever, the serum is alkaline, whilst the saliva and urine are intensely acid.

The following table will illustrate the prominent symptoms:—

Date. 1857.	Hour of day.	State of Skin, Tongue, Intellect, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.
Sept. 28	7 P. M.	Lies in a stupor; tongue dry and rough; skin dry and rough.	120	24	..	..	..
" 29	11 A. M.	Intellect brighter, but still very dull; tongue slightly coated with yellow fur and dry.	112	18	80°	95.12°	..
" 29	7 P. M.	Pulse very feeble, feels like the vibrations of a delicate silver thread; tongue and skin dry and rough.	145	34	..	..	..
" 30	2½ P. M.	Tongue moister and softer; surface of blister red, raw, and dry; urine bright red, sp. gr. 1016.	112	17	73	91.00	..
Oct. 1	2 P. M.	Restless and stupid; tongue dry and rough; teeth coated with sordes.	100	16	79	88.05	94.5°
" 2	2 P. M.	Intellect more active, but still dull; patient has a disagreeable smell; tongue coated with brownish-yellow fur, and harsh, dry, and rough; the incision in the arm where he was bled has not healed, limpid serum issues from it; side of head swollen and painful.	124	18	..	..	..
" 3	2½ P. M.	Tongue moist and soft; arm in which he was bled greatly swollen, veins of surface filled with blood; swelling of arm due to pressure.	120	24	..	..	..
" 4	2 P. M.	Swelling of arm and upon left side of face continues to increase; blister purplish red, with dry raw surface; boils and ulcers are appearing upon different parts of the body; tongue red, dry, and glazed at tip; root covered with brownish-yellow fur.	120	24	76	100.05	..
" 5	2 P. M.	Swelling of arm stationary; swelling upon side of face continues to increase.	118	..	73	100 00	..
" 6	4 P. M.	Skin hot and dry; complains greatly of his head; carotid arteries throbbing violently; since the commencement of the inflammation, the pulse has been fuller and stronger.	104	24	72	101.00	104.0
" 7	4 P. M.	When the arm is bent, much serum issues from the lancet wound; surface of blister red and raw, and shows no disposition to heal.	..	..	..	102.00	104.0
" 9	4 P. M.	Abscess upon side of head has been lanced; it discharged much pus.	168	..	..	..	..
" 10	4 P. M.	Skin hot and dry; tongue dry and rough; abscess in angle of jaw continues to discharge much pus and masses of cellular tissue; arm looks badly; skin of arm greenish yellow.	130	28	70	103.75	104.5
" 12	..	Surface of blister has commenced to suppurate, and discharges unhealthy offensive pus; the ulcers upon various parts of the body steadily increase in size, and, like the blister, discharge offensive matter.	..	..	..	..	..
" 13	..	The arm looks dreadfully; skin over biceps muscle black and gangrenous; bowels loose; digestion bad	..	..	..	..	..
" 17	..	The skin over the entire region of the biceps has sloughed away, and left the red quivering muscles; no hemorrhage; body emits a disgusting stench.	..	..	..	..	..
" 21	..	Continues to grow worse; impossible to give any idea of his distressing, offensive, and disgusting situation! Died October 22d.	..	..	..	..	..

In this report of the symptoms of this patient, we have a demonstration of the powerful effects of the malarial poison when unchecked. We see that a few days after his entrance into the hospital, a large abscess formed upon the side of his head, in the region of the ear, and joint and angle of the inferior maxillary bone. Notwithstanding that this abscess was lanced, the pus formed an entrance into the external meatus auditorius. Large masses of cellular tissue and muscles sloughed away, and the angle and supe-

rior portion of the inferior maxillary bone were almost completely stripped of flesh. The abscess compelled him to lie upon the opposite side of his body, and finally the skin over the biceps muscle changed to a black color, and sloughed off in a single night, leaving the red quivering muscles entirely exposed. The biceps muscle sloughed entirely off from its lower attachment.

After death, his liver presented a color a shade lighter than the slate color of the malarial fever liver, and in many parts it was regaining its normal hue. Spleen enlarged; surface covered with effused coagulable lymph, and bound to the liver and diaphragm by bands of coagulable lymph. A large quantity of pus of a greenish-yellow color issued from the anterior border of the spleen. Whether the abscess had opened and discharged this pus before death, or whether the abscess was accidentally ruptured during the opening of the chest and abdomen, I was unable to determine. The structure of the spleen felt firm, and very unlike the soft, yielding structure of the spleen of the active stages of malarial fever. When cut, many portions of the spleen resembled the cut surface of a dark, bronzed malarial liver. The pulp of these portions was not soft, and did not pour out like the pulp of the spleen of the active stages of malarial fever. The liver-like substance of the spleen was found to consist, under the microscope, of fibrous tissue and numerous colored corpuscles and flakes, composed of granules resembling the dark-colored flakes of black-vomit. These flakes were, without doubt, composed of altered colored corpuscles. The colorless corpuscles of this portion of the spleen appeared to be more numerous than normal. This dark liver-like substance appears to be nothing more than the pulp and effused blood of the spleen, from which the serum has in a great measure been removed, and in which alterations of the blood-corpuscles have taken place, and fibrous tissue formed. After many hours' exposure to the oxygen of the atmosphere, the color of this portion of the spleen remained unchanged.

In addition to the abscess opening upon the surface of the spleen attached to the liver, the substance of the spleen contained numerous other abscesses of various sizes (the three largest were of the size of a bullet, and the smallest of the size of an English pea), filled with thick greenish-yellow pus. Portions of the spleen especially surrounding the abscesses, were altered into a cheese-like substance. Under the microscope, these cheese-like portions consisted almost

entirely of pus corpuscles and large cells, containing granules and other smaller cells, thus resembling cancer-cells; and also black masses composed of granules (probably altered colored corpuscles), like those from the denser portions of the spleen; and also numerous oil-globules. The bodies resembling cancer-cells were not numerous. The pus issuing from the large abscess resembled ordinary pus under the microscope, and contained a few of those peculiar cancer-like cells.

The bile presented a brownish-yellow opaque color when seen in mass, and a gamboge-yellow in thin layers. The bile contained numerous irregularly-shaped yellow masses of various sizes, from an English pea to a grain of sand. These yellow masses, which were soft and readily crushed between the fingers, formed about two-fifths of the contents of the gall-bladder, and were found, under the microscope, to consist of numerous cells from the mucous membrane of the gall-bladder, and a yellow amorphous matter. The cystic duct appeared to be choked up with these cells and this yellow matter.

The stomach, and small and large intestines were greatly contracted. The mucous membrane of the stomach presented an appearance resembling that of chronic inflammation. The exterior of the large and small intestines was of a purplish color. The mucous membrane did not appear to the naked eye to be altered in structure. The glands of Peyer were enlarged and distinct; some of them were several inches in length. They were paler than usual, and did not present the appearance of active inflammation. The lymphatics of the mesentery were much enlarged.

This case demonstrates that the action of the malarial poison is chiefly through the sympathetic nervous system, and that its effects, even after the direct action is checked, result in a further perversion of the blood, and organs, and tissues. Whilst the cerebro-spinal nervous system had recovered in a great measure from the effects of the poison, and sensation, and motion, and intelligence were restored, the pathological alterations of the spleen and alimentary canal, and of the liver and blood, continued.

Many, if not all, the nervous affections and neuralgias occurring after attacks of malarial fever, or after the long-continued action of the malarial poison, in miasmatical situations, are connected with the altered state of the blood, and organs, and secretions.

Alterations of the solids, similar to the one just recorded, have been observed by Dr. Samuel Jackson, of Northumberland, Pa.

The following cases of gangrænopsis, or gangrenous erosion of the cheek, following malarial fever, are quoted from his interesting article, published thirty-two years ago, in the *American Medical Recorder*:—

"CASE 1. Mary, aged six years, daughter of John Eisely, of Sunbury, was seized, in September, 1822, with an epidemic remittent fever, which, in a few days, and before they obtained medical aid, had resolved itself into the intermittent form. I was called about the tenth day of her disease, when one side of her face was greatly swelled, pale, and shining; eyelids of the same side so œdematous as to close the eye entirely; lips, and particularly the upper one, tumefied; saliva streaming from her mouth; breath highly offensive.

My first impression was that she was affected with mercury; but they assured me, as indeed they always did afterwards, that she had taken no other medicine than the common purging salts, which they had given without medical advice.

Upon opening the mouth, I found on the inside of the tumefied cheek a patch of gangrene, about as large as a crown piece, and without anything like a line of separation. It exhibited a singular ash-color, approaching to whiteness; but it was plainly the substance of the cheek, which was dead and disorganized to a considerable depth. The teeth were all fast, the gums sound and not the least sore on pressure, nor did her breath smell precisely like that of a salivated patient. This affection had begun two or three days before, and had been steadily increasing. The disease was totally unknown to me; but the mere indications of cure were not supposed to be at all mysterious, though I am far from certain of having fallen on the most successful means of fulfilling them.

An epispastic was applied to the cheek; the mouth was very frequently washed with a succession of gargles, strong alum-water, Huxham's tinct., diluted muriat. acid; and bark, wine, elixir vit., and tonic diet were given as freely as the patient could bear them. The intermittent was checked at once, and the patient's health began to improve before the swelling of the cheek subsided in the least, or any line of separation could be seen. The tonic medicines and diet were continued, and another blister drawn as soon as the first healed.

But the state of the cheek meliorated slowly, and I was particularly struck with the obstinacy of the swelling, and the inability of

the system to form a line of separation. At the 20th day from the time I was called the slough came away, leaving a healthy ulcer, which had nearly penetrated the cheek. The teeth and gums were not the least affected at any period of the disease.

Case 2. About the same time, George Gaus, of Sunbury, called me to visit his family, three of whom were ill of intermittent fever and dysentery.

His daughter, about four or five years old, had also the cheek disease, precisely similar to that of the above child, unless that there was very little, if any discharge of saliva.

The father assured me that she had not taken one particle of mercury in any form; nor can I possibly believe that either he or Eisely deceived me, or that they were deceived themselves; nor, indeed, ought this cause of itself to have excited any inquiries concerning this mineral, since it was not attended with any flow of saliva; and, moreover, as in the above case, the teeth and gums were in a healthy state. Her dysentery was cured with large doses of calomel, jalap, and other purgatives; and at the same time a sufficient quantity of bark was given to check the fever. During this time, probably, not less than a hundred and fifty grains of calomel were given, notwithstanding the state of the cheek.

For the gangrene she was treated precisely as Eisely's daughter. She soon recovered her health, but with a frightful ulcer, which, however, did not quite penetrate the cheek.

How the ulcers in these two cases healed I know not, as I was soon taken with the epidemic myself, and confined for several weeks. I went to see these patients since writing the above; Eisely's daughter is dead; but the other is a blooming girl, without the least deformity. It is not probable that these sphacelations could have been arrested without medical aid, though it must be confessed that their character appeared to be rather indolent and obstinate, than inflammatory and phagedenic. They gave me no uneasiness at the time, but subsequent experience has convinced me that had the debilitation of the primary diseases proceeded a few days longer, the patients might have been brought into the utmost danger.

Case 3. This occurred September, 1823, in a child of Hannah Smith, of Northumberland.

He was a robust boy of three years old, who had been taken with epidemic remittent fever, for which he was treated with vene-

section, cathartics, antimonials, cold water to the head, and probably with something more that I cannot now recollect. He appeared to be going on well till the tenth day, when he was taken with an incessant agitation of all his limbs, his brain and mind at the same time apparently quite unaffected. An epispastic was applied to each limb, and nauseating doses of tartar emetic, conjoined with laudanum, were given every hour, with the hope of obtaining both an antispasmodic and diaphoretic effect; the exact dose I do not recollect.

This troublesome symptom subsided in about forty-eight hours, when the dreadful disease of which we are treating was observed in the cheek. Its *prima facies* is so peculiar that we recognized it in one moment as the same disease we had seen before in the two preceding cases; a swelling and hardness of one cheek, with the upper lip slightly tumid, led us at once to suspect the existence of mischief within; nor were we disappointed. A little cineritious spot, or rather tumor, was seen behind the opening of the Stenonian duct, without any symptom of inflammation near it, or in any part of the mouth. As we were alive to the operations of mercury, it was not a little gratifying to find the teeth and gums apparently quite sound, and not the least sore on pressure; and also that the saliva was not increased, nor the breath offensive.

The fever continued, and therefore general tonics were not admissible. A blister was drawn on the cheek, and the mouth washed frequently with a strong solution of alum. At this time the swelling was very moderate, and the mortification confined to a point. But the face swelled rapidly on that side, and the gangrene proceeded without giving any hopes of a line of separation.

In two days, the pulse became soft and slow, and, the fever being now arrested, we forthwith used tonic diet, bark, and elixir vit., with the bark poultice to the face. The mouth was washed alternately with Huxham's tincture and muriatic acid, diluted with four times its weight of water, and the sphacelated part was circumscribed twice a day with the nitrate of mercury, according to the plan of Mr. Kirkland, until it was fairly ascertained to be utterly useless. The disease continued its deadly progress till the poor child was relieved of life, about the twenty-fifth day of the gangrene.

During all this time, he suffered very little, if any, pain, and he had a ravenous appetite till the last two or three days, though much poisonous matter must have been continually passing into the sto-

mach. In fact, we were greatly surprised to find him living so long, when we consider the deleterious effects of mortification on the general system; which, in this case, we did nothing to counteract, after we found it impossible to preserve a tolerable visage.

One side of this poor child's face was literally destroyed as high as the frontal sinus; the teeth, maxillary, malar, palate, nasal, and orbitar bones were cast off or were picked away by the patient. One whole side of the face, including the mouth, chin, nose, and one eye were eaten away—a horrible sight, which even to name is a revolting duty. Yet, even in this deplorable state of things, many parts of the face put on signs of healing, and, as the patient had a good appetite, we felt no little alarm lest he might continue to live in this deplorable condition.

This child had taken some purges of calomel, jalap, and scammony, in composition, all which operated freely. The breath was not that of a salivated patient; there was no flow of saliva, as in the first case, nor did he take any calomel which was not combined with the above mentioned active cathartics.

We gave him large doses of laudanum, in order that he might sleep away in comfort the remainder of his life, and that the mother might attend to the rest of her family, all of whom were sick; and it is a little surprising that, towards the last, he would take more than half an ounce in twenty-four hours, without procuring more than ordinary sleep.

Case 4. In August, 1825, we saw a case exactly similar to this in the town of Milton, twelve miles above us. It was in a boy four or five years old, the son of one Miller, who still resides in that borough.

The patient had been treated for bilious fever, and had, like the little Smith, taken purges containing calomel; and like him, too, nearly the whole face was eaten away, after the sphacelation had lasted several weeks. We believe that no calomel was given which had not been combined with more active cathartics; but we have no means of getting at the exact history of the case.

Case 5. This was the next that came under my own care, and, *horribile dictu*, it was in my own child.

This little girl, less than two years old, was debilitated by a variety of diseases in too rapid succession; an attack of habitual intermittent, cynanche tonsillaris, measles, inflammation of the lungs, influenza, and finally her intermittent again; all which con-

fined her about ten weeks, and had nearly brought her to the grave.

When she was in a state of extreme weakness, we observed one side of her face a little swelled. I recognized the tumor at once, and heard, with the utmost dismay, the little sufferer say, 'Cheek, cheek!' while at the same time she put her hand to the affected part. On opening her mouth, I found the characteristic gangrene; but it was not larger than a dime piece, and was nearly circumscribed with a healthy periphery. Her catenation of maladies having ended in her old intermittent, we were ready to give quinine and tonic diet.

This case was attended with an odor of the breath altogether peculiar and indescribable. Only one dose of calomel had been given as a purge, and there was no affection whatever of the teeth and gums, nor any flow of saliva."

Dr. Samuel Jackson gives other cases of this remarkable affection, and proves that the affection was not due to the action of mercury.

"That rule of philosophizing, therefore, which refers the same phenomena to the same cause, excludes calomel as a direct agent in gangrænopsis.

All the cases that we have seen were preceded by bilious fever, a disease that generally has a tendency to spend its violence in some particular part; and, therefore, if any irritation, and particularly one that debilitates, should attract and fix the morbific influence, a mortification may be the consequence.

In one case of this fever, we knew blisters to mortify, and in several instances we have known a lingering sphacelation of the soft parts covering the lumbar vertebræ.

Upon this principle, then, can mercury have an indirect agency in the gangrænopsis?

It is well known that children cannot be easily salivated; but it is not reasonable to suppose that mercury has, even in them, its specific tendency to the jaws; and, if so, may it not predispose these parts to this fatal gangrene, and create that morbific attraction that brings upon them the whole weight of general disease? *Pars dolens trahit* is a maxim in medicine as true as any of the Newtonian Principia, and is of wonderful efficacy in explaining the mysteries of morbid catenations.

For our own part, we believe that mercury has no direct agency

in gangrænopsis. It may possibly irritate and predispose the part, and thus establish a catenation of morbid attraction, and so may any other local and debilitating irritation. Upon this principle, we have supposed that the disease may arise from any injury done to the part, while the system is pervaded by a sphacelating influence, as no doubt it is in many cases of fever."[1]

The blood in No. 9 was abstracted from a young American seaman—aged 21 years—with a moderately well-developed muscular system, who had been exposed to the malarious influence in the Savannah River, when sleeping on the deck of the ship in the open air. The ship was lying along the low marshy shore below the city. This patient was brought into the hospital in a comatose condition, with rapid, feeble pulse, and rapid respiration, with no corresponding elevation of temperature. This patient lay in this comatose condition, passing his urine and feces for several days, until aroused by cut-cups, sinapisms, stimulants, and sulphate of quinia.

The blood was obtained, whilst he was in this condition, three days after his entrance into the hospital, and six days after the commencment of the attack.

Blood coagulated more slowly than usual.

Serum of a deep golden color. Nitric acid showed that this color was due to the presence of bile. Reaction of serum alkaline.

The colored blood-corpuscles were greatly diminished; the dried corpuscles being 85.968, and the moist 343.872, in 1000 parts of blood. The fixed saline constituents of the colored blood-corpuscles were greatly diminished in amount, whilst those of the liquor sanguinis were increased.

The fibrin was diminished in amount.

The following table will present a condensed view of the prominent symptoms:—

[1] "On the Gangrænopsis, or Gangrenous Erosion of the Cheek," by Samuel Jackson, M. D., of Northumberland, Pa. American Medical Recorder, 1827, vol. xii. pp. 66–96.

DATE. 1857.	HOUR OF DAY.	STATE OF SKIN, TONGUE, INTELLECT, &C.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	CHARACTERS OF URINE.
Sep. 26	..	Tongue dryer than normal; coated with yellow fur; complexion sallow; has fever, is very weak and dull.	..	..	..	..	..	
" 27	..	Comatose; passes urine and excrements in bed.	..	..	..	..	..	
" 28	..	Restored to the temporary and partial use of his intellect by a blister.	..	..	..	..	..	
" 28	7 P. M.	The action of the blister has been only temporary; pulse is so feeble that it is with difficulty counted; tongue coated with yellow fur, dry and rough.	120	22	..	..	..	
" 29	11 A. M.	Lies in a stupor, with mouth and eyes partially open; teeth coated with sordes; tongue coated with black and light yellow fur, perfectly dry and rough; surface of blister red and raw.	..	..	..	..	..	
" 29	7½ P. M.	Stimulants and sulphate of quinia have aroused him, and excited the chemical changes; is still very weak, and has a great tendency to sleep; skin of head and trunk feels a little warmer than normal, and is slightly moist; tongue presents the same dry, coated, rough appearance; reaction of saliva decidedly acid.	98	18	80°	98.0°	..	
" 30	2 P. M.	Intellect clear, and there is less tendency to sleep; tongue is still very dry, rough, and black in the centre; it appears, however, softer; reaction of saliva decidedly acid.	80	14	71.0	97.0	..	High colored; sp. gr. 1016; uric acid in 1000 p'ts 0.59.
Oct. 1	1 P. M.	Tongue moister, softer, and cleaner; says that he feels better, and is hungry; complexion sallow, anemic.	90	20	73.0	98.75	101°	Deep orange color; sp. gr. 1016; uric acid in 1000 parts 0.659.
" 2	1 P. M.	The expression of countenance is better, and the surface of the blister looks much better; tongue still coated with dark-brown fur, but moister and softer; the sordes around the teeth and the disagreeable smell are rapidly disappearing; abdomen tumid; was able to walk across the ward.	88	18	77.0	102.0	..	Orange colored; sp. gr. 1016; uric acid in 1000 p'ts 0.511; deposited a heavy light-yellow deposit after standing.
" 3	1 P. M.	Has taken a change for the worse; inclined to stupor; goes to sleep whilst conversing; countenance anxious and distressed; bowels costive; during the last four days, has taken 100 grs. of sulphate of quinia.	94	18	77.0	102.5	..	Light orange color; sp. gr. 1006; uric acid in 1000 parts 0.238.
" 5	2 P. M.	Anxious expression of countenance; bowels costive; abdomen tumid; tongue a little softer and cleaner, but still much dryer, harder, and rougher than normal; there is still an almost complete cessation of the secretions of the mouth.	90	15	74.0	96.0	103.0	Sp. gr. 1006; reaction alkaline after standing 24 hours; uric acid in 1000 p'ts 0.078.
" 6	1 P. M.	Tongue clean, and much moister and softer; the moisture, however, varies greatly; pulse very weak, feels like the vibrations of a spider's thread; greatly exhausted by the action of a purgative administered the night before.	100	..	..	..	..	
" 7	3 P. M.	Under the action of stimulants has improved, and looks better; tongue softer and moister than it has been during his sickness; pulse stronger, but still watery and feeble.	92	13	70.5	97.0	103.0	
" 8	2½ P. M.	Complains of great weakness; pulse feeble and watery; bowels inactive and tumid.	96	16	72.5	97.25	102 5	
" 9	2 P. M.	Complains of great weakness; his sallow complexion, anemic lips and gums. feeble pulse, and feeble forces, demonstrate that his feelings are founded upon the effects of the malarial poison. Applied large mustards to the extremities, and administered stimulants;	92	16	73.0	86.0	103.0	
		in 10 minutes after the application, the temperature of his extremities had risen 6° (from 86° to 92°), and his pulse had become much fuller, and increased 8 beats (from 92 to 100).	100	16	73.0	92.0	103.0	
		In half an hour after the application of the mustards, the temperature of his extremities had risen 16° and remained stationary.	104	16	73.0	102.0	103.2	
		Half an hour afterwards, the temperature still continued elevated.	94	16	71.0	102.0	103.0	

DATE. 1857.	HOUR OF DAY.	STATE OF SKIN, TONGUE, INTELLECT, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	CHARACTERS OF URINE.
Oct. 10	..	Much better; temperature of the extremities corresponds with that of the trunk.	..	..	..	..	..	Deep orange color; sp. gr. 1014; 12,168 grs. passed in 24 hours, containing urea 209.520 gr., uric acid 12.60 grs.
" 10	4 P. M.	Appetite good; tongue moist; convalescent.	100	16	69.5	101 0	102.5	
" 17	..	Able to walk about the hospital grounds; reaction of saliva very slightly acid.	76	14	67.0	97.25	102.0	

This case presents many points of exceeding interest, which will be fully noticed hereafter under the proper heads. It illustrates in a striking manner, the effects of the malarial poison in producing profound alterations in the blood and secretions, and demonstrates that such changes are attended by aberrated nervous and physical phenomena.

Throughout this case there was a want of correspondence between the temperature of the trunk and extremities. The temperature of the extremities was often several degrees below the normal standard, whilst the temperature of the trunk was several degrees above the standard of health. Accompanying this loss of animal heat in the extremities, and exaltation in the trunk, there was rapid, feeble pulse, normal respiration, dry, harsh skin, dry mouth, feeble digestion, torpid bowels, sluggish intellect and feeble forces. These facts, taken in connection with the analysis of the blood, show that the malarial poison has produced profound alterations in the constituents of the blood, interfered with the formation of the secretions, interfered with the chemical changes of the blood and nutritive fluids, interfered with the development and correlation of the physical, vital, and nervous forces. The dry, harsh tongue, the scanty acid secretions of the mucous membrane of the mouth, the torpor of the bowels, the high colored acid urine, the dry, harsh skin, the feeble circulation in the capillaries of the extremities, the elevation of the temperature of the trunk, the loss of harmony between the actions of the circulatory and respiratory system, all point to profound disturbances in the domain over which the sympathetic system presides. The sluggish intellect indicated derangement of the cerebro-spinal system. The feeble forces point to derangements in both the sympathetic and cerebro-spinal systems. A careful comparison of the symptoms of this patient with those of

fatal cases, shows that this was a case of such great severity that any carelessness or neglect would have been attended by a fatal termination.

Notwithstanding the administration of the most active tonics, and of the most nutritious diet, this patient exhibited, for a great length of time, the effects of the bilious remittent fever, in his pale, sallow, anemic countenance, pale lips and gums, and tottering gate.

The violent nature of the malarial fever, contracted by sleeping in the open air in the low marshy land bordering our fresh water rivers, is forcibly illustrated by the subsequent history of the crew to which this patient belonged.

I was informed, upon reliable authority, that one week after the admission of this patient into the hospital, his captain weighed anchor and sailed for New York. The crew consisted of the men whom he had compelled to sleep on board the vessel lying along the low, marshy shore. Several of the crew were unwell at the time of sailing. Before getting well out to sea, the captain and the whole crew were taken sick. In a few days, there was not a man with strength to navigate the ship. Fortunately, a small vessel perceived their signal of distress, and towed them into Darien. Before reaching this port, the captain and five out of seven of the crew, had died. There were but two remaining of eight, and these were extremely ill. The severity of the disease, in this case, resembles the accounts of African fever.

We will now, from these observations and others, present a generalized statement of the changes of the blood in malarial fever.

1. *The careful comparison of the table of the changes of the blood in malarial fever with the formula of the blood, established by laborious investigations, reveals the fact that the colored blood-corpuscles are diminished during malarial fever.*

2. *The careful comparison of these analyses with each other, reveals the fact, that the extent and rapidity of the diminution of the colored corpuscles, corresponds to the severity and extent of the disease.*

A short but violent attack of congestive or of remittent fever, in its severer forms, will accomplish as great a diminution of the colored blood-corpuscles, as a long attack of intermittent fever, or the prolonged action of the malarial poison.

These statements are borne out in the main, by the researches of Andral and Gavarret, upon the blood in intermittent fever. If their analyses be compared with those just recorded, it will be seen that whilst the blood-corpuscles are diminished, the diminu-

tion is less than in the blood of the severe cases recorded by myself. When we consider that the climate was much more healthy, and that the fevers examined by Andral and Gavarret were only of the intermittent type, and in all probability, much lighter than the intermittents of the marshes, swamps, and low-grounds, of the southern States, which generate a malaria scarcely less deadly than that of Africa, it is evident that the results of the investigations in America upon malarial fever, agree with those of Europe.

The following table presents the results obtained by Andral and Gavarret, from the examinations of the blood of six persons suffering with intermittent fever :—

Number of case.	Water in 1000 parts of blood.	Solid residue of 1000 parts of blood.	Moist Blood-Corpuscles.			Fibrin.	Solid residue of serum of 1000 parts of blood.
			Moist blood-corpuscles in 1000 parts of blood.	Water in moist blood-corpuscles of 1000 parts of blood.	Solid residue in moist blood-corpuscles in 1000 p'ts of blood.		
1	...	...	511.6	383.7	127.9	3.7	...
2	...	...	441.6	331.2	110.4	3.5	...
3	...	...	438.0	328.5	109.5	3.5	...
4	...	...	423.2	317.4	105.8	3.4	...
5	...	...	420.0	315.0	105.0	3.3	...
6	...	...	275.2	206.4	68.8	3.0	...
Maxima	847.9	221.9	511.6	373.7	127.9	3.7	91.0
Minima	778.1	152.1	275.2	206.4	68.8	3.0	71.6
Mean	811.4	188.6	417.2	309.4	104.3	3.3	80.0

MM. Leonard and Foley, of Algiers, concluded from their examinations of the blood in intermittent fever, that the proportion of globules tends either to remain stationary or to diminish.[1]

MM. Becquerel and Rodier have demonstrated that in that peculiar condition of the system called marsh cachexia, accompanied by a remarkable decoloration of the skin, and not unfrequently by dropsy, and produced by the long-continued influence of malaria, there is the greatest decrease of both the albumen and the globules.

The following table presents the analyses of marsh cachexia, executed by MM. Becquerel and Rodier.

[1] Pathological Chemistry in its Application to the Practice of Medicine. Translated from the French of MM. Becquerel and Rodier, by S. T. Speer, M. D. London, 1857, pp. 172–174.

ANALYSIS OF 1000 PARTS OF BLOOD.

	A man aged 50, suffering from marsh cachexia and general dropsy.	A man aged 48, suffering from marsh cachexia and general dropsy.	A man aged 48, suffering from marsh cachexia and general dropsy.	A man aged 23, suffering from marsh cachexia and general dropsy.	A man aged 18, suffering from marsh cachexia and general dropsy.
Specific gravity	1035.40	1040.00	1034.06	1033.85	1040.51
Water	869.34	853.75	869.71	875.67	846.31
Moist globules	268.40	407.48	269.12	224.88	338.88
Solid matters of moist globules	67.10	101.87	67.28	56.22	87.22
Water of moist globules . .	201.30	305.61	201.84	168.66	251.66
Solid matters of serum . .	61.10	41.84	59.88	63.83	62.32
Fibrin	2.36	2.54	3.13	4.27	4.15

ANALYSIS OF 1000 PARTS OF SERUM.

Specific gravity	1020.37	1016.40	1021.61	1024.15	1023.56
Water	936.40	953.29	930.08	926.75	922.98
Albumen	55.68	37.26	50.20	60.20	63.25
Extractive matters and salts .	7.92	9.45	13.72	13.05	13.77

The mean composition of the blood in marsh cachexia may be represented thus:—

ANALYSIS OF 1000 PARTS OF BLOOD (MEAN COMPOSITION OF IN FIVE CASES OF MARSH CACHEXIA)—

Specific gravity	1036.76
Water	962.38
Moist globules	303.76
Dried residue of globules	75.94
Water of globules	227.82
Solid matters of serum	57.79
Fibrin	3.39

MEAN COMPOSITION OF 1000 PARTS OF THE SERUM.

Specific gravity	1021.22
Water	935.10
Albumen	53.32
Extractive matters and salts	11.58

The following interesting remarks, with reference to the cause of the dropsy, are made by MM. Becquerel and Rodier:—

"The dropsy has been attributed to the mechanical obstacle afforded by the enlarged condition of the spleen, so common in these cases. We do not deny the possibility of such a sequence; but it is certain that in many instances we fail to discover such an amount of splenic enlargement, as would suffice to explain the occurrence of an increasing and general anasarca. In only one of

the preceding analyses of the blood in marsh cachexia, did we notice a marked degree of splenic enlargement; it was, however, insufficient to account for the serous infiltration present."[1]

We will in the next place compare the changes of the blood in malarial fever, and in the state of marsh cachexia produced by the continued action of the poison, with the changes of the blood in the different forms of dropsy.

The following tables present a resumé of the valuable investigations of MM. Becquerel and Rodier:—

Mechanical Dropsy.

Analysis of 1000 parts of Blood.				
	A female aged 65; anasarca, dependent on cancer of the stomach and pancreas.	A female aged 36; anasarca of the lower extremities, due to an abdominal tumor.	A female aged 24; ascites and anasarca, due to abdominal tumors.	A female aged 61; anasarca, dependent on cancer of the stomach.
Specific gravity	1057.01	1053.45	1060.75	1043.56
Water	802.79	810.20	828.30	842.40
Moist globules	424.92	361.30	360.08	285.48
Solid matters of moist globules	106.23	90.30	90.02	71.37
Water of moist globules	318.69	270.90	270.04	214.11
Solid matters of serum	80.20	85.50	86.03	81.85
Fibrin	1.78	4.00	5.55	5.38
Analysis of 1000 parts of Serum.				
Specific gravity	1032.51	1033.00	1028.73	1026.69
Water	900.00	894.53	905.83	913.68
Albumen	73.26	82.62	76.74	70.80
Extractive matters and salts	26.74	22.85	17.33	15.68

In the blood of mechanical dropsy we have a decrease of the globules; but the diminution is less than that of the severest forms of malarial fever, and in marsh cachexia.

It is worthy of note that other causes than mechanical operated in two of these cases. It is probable that the cancers, and the peculiar state of the system favorable to the development of cancers, may have had much to do with the pathological changes of the blood.

These cases, then, are not without objections; nevertheless, the objections only place in a still stronger light the profound alterations of the blood-corpuscles in malarial fever.

[1] Pathological Chemistry, p. 172.

Acute Dropsy.

Analysis of 1000 parts of Blood.[1]	Mean.	Maxima.	Minima.
Specific gravity	1045.84	1053.30	1037.55
Water	830.78	...	...
Moist globules	414.32	539.52	280.40
Dried residue of moist globules .	104.58	134.88	70.10
Water of moist globules . . .	309.74	404.64	210.30
Solid matters of serum . . .	61.87	65.62	57.24
Fibrin	2.77	4.10	1.25
Analysis of 1000 parts of Serum.			
Specific gravity	1022.61	1024.28	1020.05
Water	928.47	...	...
Albumen	58.52	63.18	51.12
Extractive matters and salts . .	13.01	17.14	7.74

"The globules are less liable to decrease than in cachectic dropsy; they, nevertheless, fell in one case to 70, and in another to 72. In three cases they were above 120 per 1000; in three others between 100 and 120; and in five cases between 100 and 110.

The fibrin underwent a marked diminution in two cases only, viz., between 1 and 2 per 1000; in six cases it varied from 3 to 6, while in three others it rose above 3 per 1000.

The albumen of the serum was always diminished, and in some instances this diminution was considerable; it ranged from 60 to 66 in four cases, and from 55 to 60 in six others, while in one case it fell as low as 51.02.

It is almost needless to add, that the specific gravity of both the blood and serum was always found to have fallen below the standard of health."

[1] The above table is drawn up from eleven analyses of the blood; nine of the patients were males and two females. In all, the disease set in rapidly under the following circumstances: In one case, it followed a sudden suppression of the catamenia from violent emotion; in a second, it occurred at the fifth month of pregnancy, without any appreciable cause; in a third, it followed an attack of scarlatina; in four other cases, it followed prolonged exposure to cold; in another, it resulted from sleeping on the ground in the open air, during the month of June; lastly, in three cases, the cause was inappreciable. In two of these latter, the patients were suffering from a relapse of the disease. Of these eleven patients, none entered the hospital before the fourth, or after the eleventh, day of the disease. In six cases, dropsy was the only symptom; in two, it was accompanied by fever; in two others, there was slight fever; while in another, there was vomiting, coupled with a mild attack of jaundice.

From a careful historical analysis and examination of these cases, Becquerel and Rodier drew the conclusion that acute dropsy was the result of albuminuria following congestion of the kidney.

"Under the influence of some cause or other, congestion of the kidney is produced. The congestion is indicated, along with other symptomatic phenomena, by the escape of a certain amount of albumen with the urine; this, ere long, diminishes the natural proportion of the albumen of the blood, and the latter condition in its turn gives rise to a greater or less degree of dropsy. But the congestion of the kidney is generally of much shorter duration than the modification of the blood, and its consecutive dropsy; it disappears, therefore, long before these latter phenomena; and if the patients are not examined until a certain time after the onset of the disease, they alone are observed, the escape of albumen with the urine having altogether ceased."

Now, with reference to the diminution of the blood-corpuscles and albumen in malarial fever, we can state positively that it is not due to the escape of albumen through the kidneys. I have examined specimens of urine in all the various forms and stages of malarial fever in many cases; but never but once detected albumen in the urine, and that was in the case already reported of a seaman suffering with remittent and typhoid fevers combined. We know that albumen does appear in the urine of typhoid fever; so this case forms no exception to the previous statement.

The diminution of the blood-corpuscles and albumen in malarial fever appear to be due to one or both of two causes. Either the organs destined to elaborate and prepare the blood-corpuscles and albumen do not perform their office with sufficient energy to replace the constant destruction, or else the albumen and blood-corpuscles are destroyed during the chemical changes of fever, and by the catalytic action of the malarial poison.

Cachectic Dropsies.[1]

Analysis of 1000 parts of Blood.	A man aged 60, weakened by want, and suffering from dropsy not referable to any appreciable organic cause.	A man aged 64, suffering privations of every kind, and laboring under cachectic dropsy.	A woman aged 26, laboring under cachectic dropsy, following chronic diarrhœa.	A man aged 58, suffering from anemia and cachectic dropsy, following chronic diarrhœa.	A woman aged 25, suffering from anemia, chronic diarrhœa, and cachectic dropsy.	A man laboring under cancer of the stomach and general dropsy, the result of cancerous cachexia.	An anemic female with an incessant hæmorrhoidal flux of three months' duration.	Mean composition of the blood in cachectic dropsies generally.
Specific gravity	1051.10	1031.05	1043.55	1043.82	1045.01	1034.13	1041.04	1039.66
Water	825.94	876.82	864.45	847.28	824.55	879.54	888.24	939.85
Moist globules	407.84	259.84	334.52	363.36	414 08	216.80	188.00	306.68
Solid residue of moist globules	101.96	64.96	83.63	90.84	103.52	54.20	47.00	76.67
Water of moist globules	305.88	194.88	250.89	272 52	310.56	162.60	141.00	230.01
Solid matters of serum	68.50	55.04	49.88	59.87	68.20	63.83	62.50	60.48
Fibrin	3.60	3.18	2.04	2.01	3.73	2.42	2.26	3.00
Analysis of 1000 parts of Serum.								
Specific gravity	1025.10	1020.51	1027.75	1023.89	1023.35	1023.32	1023.03	1022 67
Water	923.50	937.86	946.55	935.13	923.63	938.09	923.00	932.65
Albumen	65.43	51.30	45.61	53.38	64.05	60.81	61.40	11.40
Extractive matters and salts	11.07	10.84	7.84	11.49	12.35	11.01	15.60	55.95

A careful examination and comparison of these results, demonstrate that the destruction of the colored blood-corpuscles in the severest forms of malarial fever, and in the dropsical anemic condition called marsh cachexia, produced by the long-continued action of the malarial poison, is greater than in mechanical and acute dropsies, and equal to destruction of these important constituents of the blood in cachectic dropsies, resulting from repeated losses of blood, exhausting discharges from the bowels, long-continued exposure and privations, hunger and thirst, and from that peculiar state of the system sometimes manifested in those suffering from cancers.

These investigations establish, without the shadow of a doubt, the fact that the malarial poison, or the peculiar train of chemical changes which it excites, destroys the gland-cells of the blood.

This fact is further sustained by the greater abundance of iron in the urine of malarial fever than in that of health. This increase of iron in the urine corresponds to the destruction of the colored blood-corpuscles, and the elimination of the products resulting from their physical and chemical changes.

3. *Our researches show that the fixed saline constituents of the blood corpuscles are often diminished in malarial fever.*

[1] Becquerel & Rodier's Pathological Chemistry, pp. 167–178.

Numerous examinations of the urine in different stages of malarial fever, have convinced me that the proportion of phosphates are increased after an attack of malarial fever. If the urine excreted during convalescence be set aside for a few hours, it will rapidly change from the acid to the alkaline reaction, and a heavy deposit of prismatic (most generally) and stellate crystals of triple phosphate, and light-yellow granules, and acicular crystals of urate of ammonia, will be thrown down. So abundant are the crystals of the phosphates in the urine of convalescence, that if, after standing until the reaction is decidedly alkaline, it be held in the sunshine, thousands of these crystals of the triple phosphate will be seen, like small spangles of silver. It is probable that a portion of these phosphates, at least, has been derived from the dead, disintegrated, chemically altered, colored blood-corpuscles.

The bearing of these facts upon pathological and therapeutical science, is placed in a clear light by a consideration of the phenomena and offices of the colored blood-corpuscles.

The specific gravity of the colored blood-corpuscle varies with the quantity of hæmatin which they contain, and with the state of concentration or dilution of its contents. The density of the fluid contents will depend upon the character and rapidity of the mutual interchanges of the cellular fluid of the blood-corpuscles and the surrounding liquor sanguinis. Constant action and reaction are kept up between these two great elements of the blood. Each corpuscle is a cell, resembling in its nutrition, growth, and general structure the active agents in the formation, elaboration, and separation of all secretions and excretions. Their cell-walls possess the property of separating from the surrounding medium certain organic and mineral compounds. If a blood-corpuscle be placed in water, it swells up and finally bursts. If it be placed in a solution denser than its internal contents, they pass out more rapidly than the exterior solution passes in, and the cell-wall swells up. The same physical laws of endosmose are at work in the animal economy. A mutual action and reaction is incessantly carried on between the interior contents of the blood-corpuscles and the exterior liquor sanguinis. Whenever water or liquids of low specific gravity are introduced into the circulatory system they dilute the serum, and immediately there is an endosmose of the less dense fluid into the denser contents of the corpuscles. Whenever water is withheld, the liquor sanguinis continually loses this element by evaporation from the surface of the lungs and skin, and by the action of the

kidneys becomes denser than the contents of the corpuscles, and exosmose takes place into the surrounding medium. The cell-wall modifies the physical and chemical properties of every molecule of liquor sanguinis that passes through its structure.

In pathological conditions the cell-wall may be altered in chemical and physical condition. This alteration will necessarily be attended by disturbance of the physical and chemical relations of the exterior liquor sanguinis to the interior cellular fluid.

In pathological conditions (as we have just demonstrated in malarial fever) any one or all the mineral and organic constituents of the blood-corpuscles may be altered physically and chemically. These alterations will be attended by corresponding alterations in the minute actions and reactions of the liquor sanguinis and cellular fluid.

In pathological conditions, any one or all the constituents of the liquor sanguinis may be altered, physically and chemically, and exist either in deficiency or excess; or some new constituent may be introduced.

These alterations may interfere with the physical and chemical alterations of the blood-corpuscles; and may even prevent the development and nutrition of the blood-corpuscles; may be attended by a perversion of all the chemical and physical actions, and final death of the blood-corpuscles.

These views are borne out by the fact, that whilst in healthy human blood the density of the blood-corpuscles varies in man from 1088.5 to 1088.9, and in woman from 1088.0 to 1088.6, in diseases the density is not confined to these limits; for in cholera Schmidt found that the specific gravity of the blood-corpuscles was increased to 1102.5, or even to 1102.7; whilst in dysentery it was diminished to 1085.5, in albuminuria to 1085.5, and in dropsies to 1081.9.

Any alteration in the constituents of the blood corpuscles must alone, independently of any actual destruction, produce disturbances in the muscular and nervous systems. The truth of this assertion is evident, when we reflect that one of the most important results demonstrated by the researches which we recorded in a former chapter, was that the development of the muscular and nervous systems was always attended by an increase of colored corpuscles in the animal kingdom.

The researches of C. Schmidt have shown that the fluid contents of the blood-corpuscles contain, in addition to peculiar organic

matters, a preponderance of the phosphates and potash salts; whilst the liquor sanguinis contains the chloride of sodium in large amount, with a little chloride of potassium and phosphate of soda.

In the blood-cells the fatty acids and globulin are combined both with potash and soda; whilst in the plasma the organic materials are combined only with soda.

The researches of Liebig, confirmed by those of Schmidt, have shown that the fluid contained in the tubules of muscles is like that of the blood-corpuscles, exceedingly rich in the phosphates and potash salts. The phosphates also exist in large amount in the brain.

These facts not only show that the blood-corpuscles may separate and elaborate from the liquor sanguinis those organic and inorganic compounds which constitute the most important part of the structures of the muscles and brain, but they also show that alteration or destruction of the colored corpuscles must be attended by aberrated muscular and nervous action. Numerous physiological and pathological facts might be brought forward to support these views. *They not only throw light upon many of the phenomena of malarial fever, especially those connected with the circulatory, muscular, respiratory, and nervous systems, but they also indicate certain important principles of treatment.*

(a.) *Bloodletting should be avoided, as a general rule, in malarial fever.*

This principle applies to general, and not local bloodletting.

I have used local bloodletting (cut cups) in scores of cases of malarial fever, and always with apparent benefit. Over the epigastrium, it often arrests obstinate vomiting, and over the temples and back of neck and over the spine, it often relieves distressing pain.

Local differs from general bloodletting in two essential degrees.

First, the quantity of blood abstracted is much less, and second, the number of colored blood-corpuscles is less in proportion to the amount of blood abstracted in local, than in general bloodletting. The colored blood-corpuscles rush along in the centre of the streams, and in general bloodletting they are lost more rapidly than the other constituents of the blood.

The malarial poison, whatever it be, destroys rapidly the colored blood-corpuscles. Whatever, therefore, diminishes the colored blood-corpuscles, acts in concert with the malarial poison.

The malarial poison reduces rapidly the forces.

General bloodletting reduces rapidly the forces. The two in this particular, again act in concert.

We would not for one moment deny that circumstances may arise, when bloodletting would be beneficial in malarial fever. Whenever it is used, it should be borne in mind that it does not, and cannot cure the disease. Its beneficial action is only temporary, and so far from curing the disease, the relief which it has temporarily afforded will vanish, if other remedies, especially the sulphate of quinia, be not used, and as a general rule, without these remedies, the patient will be in a much worse condition than if the bloodletting had not been employed.

In the use of bloodletting in malarial fever, we should ever remember that the cerebral symptoms, the delirium and the torpor of the intellectual faculties, and the congestion of the internal organs, are not inflammatory; they are not due to an exaltation of the functions, or to an irritation of the congested organs, but rather to a loss of power in the circulatory apparatus, heart, arteries, capillaries, and veins, and to disturbances of the physical, chemical, and nervous forces.

The blood stagnates, and accumulates in the capillaries of important organs, because the blood has been altered by the malarial poison, and the changes which it induces; because the relations between the blood and its containing vessels, especially the capillaries, have been disturbed; because the regular, normal chemical changes necessary for the development of the forces which work the machinery, are not generated with sufficient energy, or if generated with even increased energy, they are not generated in the right position and in the proper quantities, and the correlation of the physical, chemical, nervous and vital forces is thus deranged; because the action of the sympathetic nervous system which accompanies the bloodvessels, and regulates the circulation, and respiration, and secretion, and nutrition, and excretion, and relates them to each other and to the cerebro-spinal system, has been disturbed by the direct and indirect action of the poison, by the direct action of the poison upon the sympathetic and cerebro-spinal nervous systems, or by the relations of the chemical changes induced, or the products generated in the constituents of the blood, by the malarial poison, to the sympathetic and cerebro-spinal nervous systems.

We will ilustrate these principles of treatment by a single case of congestive fever, selected from a multitude, every one substantiating these statements.

Case Illustrating the Effects of Bloodletting in Malarial Fever.—German, aged 27; height 5 feet 9 inches; weight 160 pounds; brown hair, blue eyes, florid complexion; thick-set, stout and muscular; thick, short neck; person filthy; habits intemperate.

Last winter and spring he was in the hospital with a large ulcer upon the leg. Has been working for three weeks in a malarious locality, near Lover's Lane, on Thunderbolt road. Has been much exposed to the hot sun and cold night air.

August 21st, 1 o'clock P. M., 1857. Entered the Savannah Hospital yesterday afternoon, at 4 o'clock P. M. The nurse states that during the night he appeared to be out of his head, and would frequently start out of bed with a loud shout. Complained bitterly of his head. Had two convulsions during the night, one at 12 P. M., and the other at 2 A. M.

Now, 1 o'clock P. M., this patient appears to be suffering intense agony in his head, and has a hot fever. Both hands are clasped around his head, and he tosses violently about in his bed. Every breath is accompanied with a deep groan, and an exclamation about the pain in his head. He is unable to give a coherent answer.

Applied immediately four cut-cups to his head (two to back of neck, and two to temples); also a large mustard plaster over his epigastrium, and one to each leg. Abstracted f℥xviij of blood in the standing posture, until he fell back upon the bed, completely exhausted.

The loss of blood was attended with almost immediate relief of the pain in his head. The burning heat of the head and skin was almost immediately diminished, and the dry and parched skin was soon covered with perspiration.

The pulse and respiration were diminished in frequency.

Respiration, 39; pulse, 92. Temperature of atmosphere, 80° F.; temp. of hand, 89; temp. under tongue, 97.

The temperature under the tongue is 3°, and the temperature of the extremities is 9° below the normal standard. The temperature was not ascertained by the thermometer before the abstraction of blood, owing to the great suffering and restlessness of the patient, but judging by the sense of touch, it is evident that the temperature has diminished rapidly since the abstraction of blood. The wild and restless glances of his eye, and the violent tossing of his body, have ceased, the pain in his head has almost entirely disappeared, his intellect is calm, and he converses rationally. Tongue thickly coated with yellow and black fur, tip and edges clean and of

a scarlet color. Previous to the bleeding, the tongue was dry, rough, and where the fur was absent, glazed; now it is more moist, but still much dryer than normal.

He is now able to give an account of his case, and states that the fever came on three days ago, with a chill, and pain in the head; and that it has continued unabated, up to the present time. Says that he took blue pills and oil yesterday morning, before entering the hospital, which operated freely. Complains of great thirst.

℞.—Citrate of potassa ℥j; bicarbonate of potassa ʒj; water f℥xxviij. Sig.—Drink ad libitum.

22d, 12 o'clock M. Head is well. Has not complained of his head since the abstraction of blood. Superior portion of tongue coated with thick, dry, yellow fur, inclining to black in the centre. Tip of tongue clean, bright red, dry and glazed. Complains of an unquenchable thirst. Lies quietly.

Respiration 52, hurried, labored, thoracic, striking the attention of the most casual observer.

Pulse, 112; respiration, 52. Temperature of atmosphere, 81° F.; temp. of hand, 99; temp. under tongue, 104.

Skin of trunk feels hot to the hand. Epigastrium very tender under pressure.

℞.—Blister six inches by six inches over epigastric region. ℞.—Calomel gr. v; rhubarb gr. viij. Mix. Gruel and flaxseed tea.

23d, 12 o'clock M. Says that his head is much better, and he feels perfectly well.

Blister has drawn; serum from the blistered surface of a golden color. Medicine operated four times; evacuations small. The tongue presents the same appearance. Tenderness of epigastrium greatly diminished.

Pulse, 72; respiration 34, thoracic, labored. Temperature of atmosphere, 78° F.; temp. of hand, 89; temp. under tongue, 96 to 96.5; skin feels cool.

The temperature under the tongue is 3°, and the temperature of the hand 8° below the normal standard. There is great want of co-ordination between the circulation, respiration, and chemical changes. ℞.—Calomel gr. xij; James' powder (pulvis antimonii compositus) gr. xxij. Mix and divide into six powders, and administer one powder every three hours, in a tablespoonful of snake-root tea. Sponge skin with salt dissolved in dilute alcohol. Diet, gruel and gum-water.

24th, 9½ o'clock A. M. The nurse states that he has been restless during the night, and apparently out of his head. Several times he sprang out of the bed with a loud shout. At one time he insisted that he was perfectly well, and affirmed that he was going down to the hotel to get a cup of coffee, some boiled eggs, and a good drink of brandy. Now, his respiration is spasmodic, 40 to the minute. Pulse cannot be felt. Have administered brandy, but he is unable to swallow, or to articulate. He died fifteen minutes after this observation. His death struggles were severe and distressing. Deep and violent inspirations and expirations; mouth filled with froth which was scattered in every direction, with the violent expirations.

The examination of the body four hours after death, demonstrated, that whilst the blood was congested, stagnated in the capillaries and veins of the brain, and lower dependent portions of the lungs and skin, and organs, and muscles generally, and of the intestines, there were no marks of inflammation.

The slate-colored liver; the dark greenish-brown bile; the absence of grape sugar, and the presence of animal starch in the liver; the slate-colored, enlarged, engorged, softened, spleen; demonstrated that this was a case of malarial fever; the rapid, feeble pulse; rapid, labored respiration; and depressed temperature of the trunk and extremities, marked this case, as belonging to that type of malarial fever called congestive fever.

After the abstraction of blood, there was no correspondence between the circulation, respiration, and chemical changes. Before the abstraction of blood, there was a rapid pulse; rapid, full, thoracic, labored respiration, and dry, hot skin, and dry, red tongue, accompanied by violent pain in the head. After the abstraction of blood, and the application of mustards, there was a slight reduction of the temperature of the trunk and extremities; the temperature of the extremities was reduced 9° below that of health; the pain in the head vanished; the tongue became a little more moist, but none the less red.

To a casual observer, the disease would appear, in a great measure, to have been conquered by the abstraction of blood; the symptoms, however, were only moderated. The congested bloodvessels of the brain were relieved, and the pain arising from the chemical changes, and stagnation, and engorgement of the altered blood in the bloodvessels and capillaries of this delicate organ, was correspondingly diminished. The temperature of the trunk rose

5° above the normal standard, on the next day, whilst that of the extremities just reached the normal standard. This increase was attended by a far greater acceleration of the respiration and circulation than was necessary in health, to produce this increased chemical change. We shall show, in a subsequent chapter, that if the functions of the organs and apparatus be properly performed, a full, rapid and vigorous circulation and respiration, must be attended by the rapid absorption and distribution of oxygen, and corresponding rapid chemical changes.

In this case we had the rapid circulation and respiration, but a deficiency of corresponding chemical change, and hence conclude that the malarial poison has acted, either by inducing directly such changes in the blood as to prevent its absorption of oxygen, or to prevent the rapid action of the oxygen absorbed, or by interfering with the metamorphoses of the solids and fluids of the organs, and tissues, and nutritive fluids, or by a direct action upon the structures or nerves of the heart, thus deranging the circulation of the blood, and through it all the chemical changes of nutrition, secretion, excretion, and the development of the forces, or by a direct action upon the nervous centres of the sympathetic nervous system, which preside over and relate to the circulation and respiration, and through them the chemical changes in the lungs, and heart, and bloodvessels, and capillaries, and organs, and tissues, and cerebro-spinal nervous system.

The rapid but feeble action of the heart; the rapid but feeble pulse; the depressed temperature of the trunk and extremities; the dry red tongue; the acid, light-colored urine; the feeble general and capillary circulation gradually overcome by the action of gravity; the gradual settling of the blood previous to death in the bloodvessels of the most dependent parts of all the organs and tissues; the alterations of the blood-corpuscles of the liver and spleen; the alterations in the color and constitution of the bile; the destruction of the special ferment in the blood which converts the animal starch into grape-sugar; demonstrated that the malarial poison had acted chiefly upon the sympathetic nervous system, and produced profound alterations in the structure of the nutritive fluids, and correspondingly interfered with the chemical changes, the development of the forces, and the formation of the secretions and excretions.

The theory then suggested, and most strongly supported by the case, is, that the malarial poison acted primarily and simultaneously

upon the blood, and spleen, and liver, and sympathetic nervous system, and secondarily upon the cerebro-spinal nervous system. We shall show presently that the blood in fevers is altered before the manifestation of aberrated cerebro-spinal nervous action. The same thing may be established with reference to the organs. We shall also show that the symptoms and aberrated phenomena manifested by the sympathetic nervous system precede those of the cerebro-spinal system. Nevertheless, in the present state of medical science; whilst we are ignorant of the chemical and physical properties and relations of the malarial poison; whilst we are unable to observe the first aberrations of sympathetic and cerebro-spinal nervous phenomena, manifested either in an excess or deficiency of secretion, and nutrition, and chemical change, or in a disturbance of the mutual relations of the two systems to each other, and to the respiration and circulation, and to the organs and tissues; the interests and extent of science forbid the dogmatic location of the origin of malarial fever in one system of nerves or the other, or in both, exclusive of the blood, or in the blood and organs exclusive of the two nervous systems.

The treatment of this case was radically defective. The bloodletting was proper as a means of relieving the brain, but not as a remedy applied alone, to combat the action of the malarial poison. The bloodletting relieved the brain, but the poison went on acting, altering the chemical relations of the elements of the blood, and liver, and spleen, more rapidly than ever. Here we have the cerebro-spinal difficulty apparently relieved; whilst the war is raging in the domain over which the sympathetic system is said especially to preside. There was a calm, but it was the calm of conquest; the calm of exhausted nature. The mighty foe carried forward the work of destruction without noise or confusion, because all opposition was levelled, all resistance subdued. This state of things demanded prompt and vigorous action on the part of the physician. Those remedies should have been administered which would have aroused the capillary circulation; aroused the sympathetic and cerebro-spinal nervous systems, and accelerated the absorption, and distribution, and action of oxygen, and the chemical changes of the nutritive fluids, and organs, and tissues, which are the sources of all the forces which work the machinery, and without which we can have the manifestation of no vital phenomena. Brandy, Sulphate of Quinia in large doses, and Carbonate of Ammonia, should have been promptly and freely administered, and sinapisms applied.

(b.) *Active and excessive purgation should be avoided in malarial fever.*

We should avoid excessive purgation in malarial fever, for the same reasons that general and excessive bloodletting should be avoided.

In malarial fever the blood-corpuscles are altered and destroyed to a great extent, and the fibrin and albumen are in a measure altered in quality and quantity. These alterations are attended by aberration and exhaustion of the forces, and although the alteration and destruction of the constituents of the blood may appear small, still they are sufficient to produce serious alterations in the secretions, and excretions, and serious disturbances in the forces. It is an established fact that excessive purgation exhausts the forces and diminishes the volume of blood. Excessive purgation, then, acts in concert with the malarial poison.

Judiciously used, purgatives are of essential service in all those cases of malarial fever where there is a dry hot skin, dry red tongue, moderately accelerated full bounding pulse, and moderately accelerated respiration, and high temperature in the trunk and in the extremities. In such cases our plan has been to administer to an adult from eight to ten grains of calomel in combination with seven grains of sulphate of quinia, and follow with castor oil in four hours, and commence with five grains of sulphate of quinia as soon as the purgative has operated once or twice freely, and continue five grains every three hours up to twenty-five or forty grains, according to the symptoms of the case. I have in scores of cases seen the hot dry skin become relaxed and moist, and the dry harsh tongue become soft and moist, and the restlessness and pain in the head vanish, under the action of the calomel and sulphate of quinia. I have in scores of cases seen the most obstinate paroxysms yield without any return to the vigorous administration of the sulphate of quinia after the bowels have been opened, the skin relaxed, the secretions of the mouth and liver promoted, and the portal system unloaded.

On the other hand, I have seen simple cases of remittent fever, converted into the congestive type, by the injudicious administration of purgatives, and the neglect of sulphate of quinia, stimulants and sinapisms. The efficacy of this mode of treatment, as well as the true indications and methods for the employment of purgatives, will be fully discussed and illustrated by cases in a subsequent chapter.

(c.) *Support the strength, during the severe attacks of malarial fever, with nutritious diet and stimulants.*

If the action of the malarial poison be depressing and not inflammatory; if the action of the malarial poison be destructive and not exciting, then nutritious diet and stimulants are indicated.

I have administered milk punch, wine whey, beef soup, mutton soup, and soft-boiled eggs, with positive benefit in all the forms of malarial fever. The advantage of this mode of treatment is especially evident in congestive fever, and in the severer forms of remittent fever, and in convalescence from all the various forms of malarial fever.

The nutritious diet supplies the elements of the blood which have been destroyed, and the stimulants arouse the nervous systems, and through them excite the action of the circulatory and respiratory systems, and promote the introduction and distribution of the elements of nutrition and secretion, and of the chemical changes by which the forces are generated, and also preserve the elements of the blood and tissues from too rapid chemical change, by taking their places and themselves undergoing those chemical changes which are necessary for the development of the physical forces which works the machinery.

We should never be deterred by the cerebral symptoms in malarial fever from the use of stimulants. They are due to the stagnation and congestion of the altered blood in the capillaries of the brain, as much, if not far more than to the direct action of the malarial poison. Hence, whatever will quicken the circulation and remove this, congestion and stagnation will promote the normal action of the brain and nervous system. Under the action of stimulants and sulphate of quinia, I have seen the delirious subject, with parched skin, tongue, and lips, become quiet and rational, with relaxed moist skin and mucous membrane. The efficacy of this mode of treatment will be illustrated more fully hereafter.

(d.) *Administer the salts which are deficient in the colored blood-corpuscles, as soon as the destruction of the colored blood-corpuscles has been arrested, and the malarial poison removed or diminished.*

I have derived great benefit from the administration of the Phosphates of Iron, Lime, Soda, and Potassa, in the stage of convalescence from malarial fever.

(e.) *If after the active stages of malarial fever the digestive functions are enfeebled, pepsin should be administered.*

Cases of neglected or badly treated malarial fever frequently run into what is commonly called the typhoid state, in which the digestion is enfeebled and perverted, the liver deranged, the spleen disorganized and in many cases degenerated, the blood-corpuscles diminished and altered, and the whole constitution of the blood profoundly altered. In these cases we have employed pepsin with benefit. If the gastric juice does not perform its offices, the active and essential principle of the gastric juice should be supplied. If pepsin and an acid be supplied, digestion will take place in a weak, diseased stomach as well as in the healthy stomach. The truth of this assertion has been established by the experiments of Dr. L. Corvisart,[1] of Paris, to whom the profession is indebted for the introduction of pepsin into the practice of medicine. Andral, Longet,[2] Rilliet, Barthez,[3] Grisolle, Hérard, Vogel, Schiff, Josi, Lecointe,[4] Ballard,[5] Bertholet,[6] Cahagnet,[7] Parise,[8] Huet,[9] Chambers,[10] Nelson,[11] and others,[12] have testified to the efficacy and value of pepsin in various diseases.

[1] "Dyspepsie et Consomption—Usage de la Pepsine." By Dr. L. Corvisart. Paris, 1854. "Recherches ayant pour but, d'administrer aux Malades que ne digérent point des Aliments tours digèrés par le Suc Gastrique des Animaux;" Comptes Rendus, Aug. 16, 1852—Sept. 6, 1852. "Études sur les Aliments et Nutriments—Nouvelle Méthode pour le Traitement des Malades dont l'Estomac ne digère point;" L'Union Médicale, 1854, p. 17.

[2] In typhoid fever. Bulletin Gén. de Thérap., tom. xlvii. p. 320.

[3] "Sur l'Apepsie (un absence de digestion) chez les Enfans, et sur le Traitement de cette Maladie par la Pepsine;" L'Union Médicale, Jan. 12, 1856.

[4] "Observation d'un Cas de Consomption ultime, traitée par la Poudre Nutrimentive;" Bulletin Gén. de Thérap., tom. xlix. p. 268.

[5] Artificial Digestion as a Remedy in Dyspepsia, Apepsia, and their Results. By Edward Ballard, M. D. London, 1857. This valuable work contains the method of preparing pepsin, and also reports of numerous cases of disordered digestion successfully treated with pepsin by Dr. Ballard and other practitioners of medicine.

[6] In dyspepsia of a year's duration.

[7] In dyspepsia and vomiting of several years' duration.

[8] In dyspepsia of early pregnancy.

[9] Gastralgia of several years' duration.

[10] "Practical Lectures on the Management of Digestion in Disease," by T. K. Chambers, M. D.; London Lancet, Aug. 1857, p. 101, Sept. 1857, p. 180, Am. ed.

[11] "On Mellitic Diabetes, in reference to its Treatment by Rennet or Liquor Pepticus Præp.," by David Nelson, M. D.; London Lancet, Aug. 1857, p. 118, Am. ed.

[12] "Rennet in Diabetes Mellitus," by Dr. James Gray; Glasgow Medical Journal, Oct. 1856. See also American Journal of the Medical Sciences, Jan. 1857, p. 25. "Case of Diabetes Mellitus, treated by Joseph Jones, M. D.;" Southern Medical and Surgical Journal, May, 1858.

When pepsin can be obtained pure from the apothecaries, or when the physician has time to prepare it himself, the poudres nutrimentives of Corvisart is by far the most elegant and portable preparation. Chambers[1] and others[2] have shown that much of the pepsin now sold possesses but feeble transforming powers, and it is important that the physician should be able to prepare it when needed. The following are the directions given by M. Boudalt[3] for the preparation of the medicine: "Take a sufficient number of rennet bags (the fourth stomach of the ruminants), open and reverse them, and wash them under a thin stream of cold water; scrape off the mucous membrane, reduce it to a pulp, and macerate it in distilled water for twelve hours; filter; add to the liquor a sufficient quantity of acetate of lead, and, after separating the precipitate, pass through it a current of sulphuretted hydrogen; filter again; evaporate at a low temperature to the consistence of a syrup, which is mixed intimately with starch, pulverized, and dried at a temperature of 100° Cent. In this state the gentle application of heat will reduce it to a dry mass, readily reducible to a powder of uniform efficacy."

The power of the pepsin thus obtained varies, and before the use of a specimen we should first test its transforming power. The standard dose is that quantity of the powder which, when acidulated with three drops of lactic acid, and added to fifteen grammes (225 grains) of water, would transform (digest) six grammes (90 grains) of fresh fibrin, finely cut up, and kept in a bottle, at a temperature of 40° Cent., for twelve hours, with occasional shaking. The average dose of the "poudre nutrimentive" is fifteen grains. It may be taken dry or in solution, in unfermented bread, or in a spoonful of soup, or in sweetened water. It should always be taken with, or at the commencement of, the meal on which it is to act.

The following mode, adopted and recommended by Dr. James Gray,[4] for the preparation of rennet, is far less complicated and

[1] "Experiments upon Artificial Digestion," by T. K. Chambers, M. D.; London Lancet, Aug. 1857, p. 133, Am. ed.

[2] "Experiments upon the Action of Pepsin," by Edward H. Sieveking; Medical Times and Gazette, April 4, 1857. See also American Journal of the Medical Sciences, July, 1857, p. 212.

[3] Ballard on Artificial Digestion, p. 10. See also "Mémoire sur le Principe Digestif, les Preparations Nutrimentives, et les Moyens propres à reconnaitre et à mesurer leur Action;" Acad. Imp. de Méd., Séance du 14 Février, 1854.

[4] Glasgow Medical Journal, Oct., 1856. See abstract of paper in American Journ. of Med. Sciences, Jan., 1857, p. 215.

tedious, and at the same time yields a valuable preparation of pepsin:—

"The stomach of a calf (and the younger it is the better) is gently washed with water, taking care not to injure the mucous membrane; it is then salted, tied up, and allowed to dry. After this it is cut in small pieces, macerated in a pint and a half or two pints of water, according to the size of the stomach, for four days or longer in winter, shaking it at intervals; the fluid is then poured off and bottled, and to test its power a spoonful may be added to a pint of warm milk, which, if it curdles, it is now fit for use. A little spirits, or decoction of sparrow-grass, may be added to make it keep. The dose of rennet thus prepared is a tablespoonful, three, four, or six times a day, about half an hour after each meal, and during the process of digestion, followed shortly after by an alkali, to neutralize the lactic acid formed. That which I recommend is the alkaline tribasic phosphate of soda; but the carbonate of potash will answer very well, either alone or combined with the tincture of nux vomica, in five or ten drop doses."

The stomach of the pig may also be employed. It may be prepared in the way recommended by Dr. Gray in the preparation of rennet, or it may be cut in thin slices and treated with vinegar, and the digested mass added to mutton or beef soup.

Pepsin is not the only substance concerned in the digestion of albumen and flesh.

The connective tissues and muscular fibres are disintegrated and softened, but never completely dissolved by the gastric juice. The ultimate fibrillæ of muscles, which have escaped the action of the gastric juice, pass into the small intestines, and are there digested by the pancreatic juice.

Whenever, then, meat passes entirely through the alimentary canal without being dissolved, we conclude not only that the pepsin is deficient, but also that the pancreatic juice has lost its power of digesting the ultimate fibrillæ of the muscles, which have escaped the action of the gastric juice.

Whenever the ultimate fibrillæ alone are discharged by the rectum, we must conclude that the pancreatic juice, and not the gastric juice, is at fault. In distinguishing derangements of the pancreatic from the gastric digestion, the microscope, applied to the matters thrown off from the rectum, is absolutely necessary.

As far as my observations extend, the pancreas is less affected

during the process of malarial fever, than the liver, spleen, or stomach and intestinal canal. Notwithstanding these negative results, it is important that we should know the value of treatment in derangements of the pancreatic digestion.

M. L. Corvisart[1] communicated to the Imperial Academy of Sciences, April 6, 1857, a memoir "On the Power of the Pancreas to Digest Azotized Food," in which he not only confirmed the assertion of Purkinge and Pappenheim, that the secretion of the pancreas is endowed, like the gastric juice, with the property of dissolving azotized food; and demonstrated that the pancreatic juice in disintegrating albuminoid elements effects in them a transformation identical or analogous to that which the stomach produces; but also showed that the pancreatic juice acts only on those portions of the food which have escaped the action of the gastric juice, and at the same time has no effect upon the digested products of the stomach.

When separated, the pancreatic and gastric fluids exercise their functions in full, and, when mingled in their pure state, the two digestions are arrested. The two ferments, pepsin and pancreatin, destroy each other.

In the alimentary canal, this is prevented, 1st. By the pylorus which separates the two ferments. 2d. By the gastric digestion during which the pepsin is destroyed. 3d. By the bile which destroys in its course the activity of the pancreatin.

It is evident, therefore, that the pancreatin, or the pancreatic juice, so far from assisting digestion, would retard it. M. S. Corvisart states that he had failed to receive any benefit from the administration of pancreatin for the relief of derangement of the digestion in the intestinal canal.

My own limited experience with pancreatin sustains the statements of M. S. Corvisart.

It is evident, therefore, that in the present state of science we are unable to reach, by medicines, the derangements of the pancreatic digestion of flesh. Nevertheless, the determination of the relative frequency, extent, and effects of derangements of the pancreatic digestion, is of great value. As far as my observations extend, these derangements are exceedingly rare in malarial fever.

[1] Moniteur des Hôpitaux, April 21, 1857. See also American Journal of Medical Sciences, July, 1857, p. 206.

(f.) *The excretion of the products resulting from the dead disintegrated blood-corpuscles should be promoted by diuretics and depurants.*

The necessity for the removal of these products is indicated by the fact that the urine in congestive fever is deficient in the compounds resulting from the chemical changes of the blood and tissues; whilst in intermittent and remittent fevers, in which the elevation of temperature and the chemical changes correspond to the acceleration of the respiration and circulation, the urine is loaded with the matters resulting from the chemical changes of the blood, and organs, and tissues, and apparatuses.

The Sulphate of Quinia appears not only to exert a direct effect upon the actions of the sympathetic and cerebro-spinal systems, and upon the action of the heart and capillary circulation, but it also promotes the removal of the products of the metamorphoses of the tissues.

The infusion of Virginia Snakeroot is valuable as a stimulant and diuretic.

The Bicarbonate, Citrate, and Acetate of Potassa, and the Carbonate and Acetate of Soda, are valuable depurants, both in the active stages and in convalescence.

(g.) *The liver and spleen should be roused to action if torpid, and their perverted secretions thrown off, and their normal relations to the blood re-established.*

In addition to the depurants just mentioned, we may employ the various preparations of iodine, especially the iodide of quinia; and, in some cases, the preparations of mercury in small doses.

I have witnessed the beneficial action of the iodide of quinia, both upon myself and upon others; and, as far as my experience extends, it appears to act more powerfully upon the kidneys, and depurate the blood more thoroughly, and restore the stomach, liver, and spleen more rapidly to the exercise of the normal functions, than either of those substances uncombined. The iodide of quinia is worthy of the examination of the profession.

The citrate of iron combined with the sulphate of quinia and the carbonate of soda, dissolved in the infusion of quassia, appear not only to assist in the restoration of the colored blood-corpuscles, and depuration of the blood, but they also appear to exert decided beneficial influences upon the liver and spleen.

The next points of interest are the determination of the place of the destruction of the colored blood-corpuscles, and the discussion of the question whether their disappearance be entirely due to the cessation of their birth. Do they diminish simply because new ones do not take their place?

With reference to the place of the destruction of the colored blood-corpuscles, it may be affirmed that they undergo important alterations in the spleen and liver, during the active stages of malarial fever. In examinations of the organs after death from all the forms of malarial fever, intermittent, remittent, and congestive, I have observed that the dark blood of the spleen and liver does not change to the arterial hue when exposed to the oxygen of the atmosphere.

After death from phthisis, cirrhosis of the liver, organic disease of the circulatory apparatus, apoplexy, and mechanical injuries, so far as my observations extend, the blood of the spleen and liver always changes to the arterial hue upon exposure to the action of the oxygen of the atmosphere. Chemical examinations of the blood of the liver during health have shown that the blood-corpuscles are more numerous in the blood passing out of this organ than in the portal blood.

The colored blood-corpuscles appear to originate to a certain extent in the liver, and undergo certain important chemical and physical changes in this organ.

In malarial fever, important changes take place in the blood passing through the liver; many of the colored blood-corpuscles are destroyed, and the coloring matters infiltrate the structures, and, together with the altered bile, impart the slate color to the exterior, and the bronze color to the interior, of the malarial fever liver. In some cases the coloring matter derived from the disintegrated blood-corpuscles, exists in the form of granules in the tissues of the liver. These granules, however, are by no means necessary to the slate and bronze color.

I have discovered a similar change of color in the kidneys of several patients, which presented several spots upon their surface of a dark slate color without, and bronze color within. If the blood-corpuscles were destroyed in the capillaries of the kidney, then the destruction was circumscribed, and the peculiar coloring matter resulting from the changes of the coloring matters of the blood, infiltrated only those parts of the kidney adjoining the blood-vessels and capillaries in which they were destroyed.

This curious phenomenon has been also witnessed in the livers of patients who had died suddenly in the earliest stages of malarial fever. In these cases the greater portion of the livers have presented a color but a few shades deeper than the Spanish brown; whilst one or more spots were found presenting the true malarial slate and bronze color. These facts illustrate two points. First, they show that the destruction of the colored blood-corpuscles in the liver commences at an early day in the liver; and second, that this destruction in some cases, at least, is confined at first to circumscribed portions of the liver.

Whilst the facts as yet accumulated are too few to warrant any very general or dogmatic assertions, they certainly incline our minds to the belief that the destruction of the colored blood-corpuscles in the liver are dependent upon the disturbance of the relations of the liver to the blood, rather than to the destruction of the colored blood-corpuscles in the capillaries and bloodvessels, independent of the action of the liver, simply by the direct action of the malarial poison. The changes of the blood in the liver are not confined to the destruction of the colored blood-corpuscles.

Animal starch accumulates in the malarial fever liver; whilst grape sugar, as far as my observations extend, is absent.

I have made numerous *post-mortem* examinations in all the forms of malarial fever, and tested the livers carefully for animal starch and grape sugar. The result was the same in every instance; an abundance of animal starch without a trace of grape sugar. When the malarial fever livers were washed, and small particles spread upon a glass-slide, and treated with tincture of iodine, and viewed under the microscope, numerous beautiful blue and purple masses of this animal starch, colored by the iodine, could be seen. When the fibrous capsules of the livers were torn off from the surface of the liver, and spread upon a glass-slide, and treated with tincture of iodine, these blue masses were seen scattered amongst the meshes of the fibrous tissue. The livers were set aside and examined after intervals of twelve hours. The last examination was made thirty-six hours after the first. At every examination the result was the same; an abundance of animal starch, and no grape sugar.

These facts are important, not only in their bearing upon malarial fever, but also in their bearing upon other diseases. M. Cl. Bernard has demonstrated that the transformation of glycogenic hepatic matter (animal starch), formed by the liver, into glucose, is

the result of the action of a special ferment, which is formed and exists in the blood, independent of the liver. From these facts it is probable that in malarial fever this ferment is destroyed; whilst the liver still possesses the power of transforming the nitrogenized and non-nitrogenized elements into animal starch.

The blood and blood-corpuscles undergo remarkable alterations in the spleen during malarial fever.

Upon the exterior the malarial spleen presents a dark slate color, resembling the color of the malarial liver. When held in the hand the malarial spleen feels like a bag of soft mud. The capsule and trabeculæ break upon the slightest pressure, and the fingers will often plunge into the organ, even during the most careful handling.

The reddish-brown mud (pulp) of the malarial spleen consists almost entirely of colored corpuscles in various stages of alteration and disintegration.

With the microscope I have found that in many cases, especially those of long-standing, the mud of the spleen contained numerous granules of a reddish-black color. These black granules were frequently conglomerated together, forming dark flakes, like the coffee-ground sediment of the black vomit of yellow fever, and were without doubt altered colored blood-corpuscles. In many spleens the colored blood-corpuscles have presented swollen, and distorted, and irregular forms. I have found this alteration of the spleen in all cases and in all periods of malarial fever. In one case, in which the patient died in thirty hours after the commencement of the attack, the spleen presented the same enlarged and softened condition; whilst the liver presented only spots of the slate and bronze color.

When we reflect that the malarial fever spleens often weigh one, and two, and three or more pounds, and that their principal weight is due to the presence of colored blood-corpuscles; when we further reflect that the whole amount of blood existing in the body of a grown man is about twenty pounds, and that not more than nine pounds of this exist in the form of moist colored blood-corpuscles, it is evident that the spleen in malarial fever forms a grand sepulchre for the colored blood-corpuscles. We will show in the chapter upon the changes of the organs and apparatus in malarial fever, where these subjects will be more fully discussed, that the mud of the spleen is not reabsorbed to any great extent.

We have before discussed the alterations of the fibrin, and the changes of the color of the serum; it remains now to state that the albumen is diminished in malarial fever; whilst the extractive matters of the serum are increased.

Professor Cozzi has also shown that the cholesterin was increased in the blood; whilst the phosphates, and fat, and albumen were diminished. Whether the cholesterin was derived from the bile or from the brain, or from both, has not been determined.

We will now compare the changes of the blood in malarial fever with those of other diseases.

The following table, constructed from a minute and laborious examination, and calculation, and classification of the most important researches upon the changes of the blood in disease, will give a condensed résumé of this department of pathological chemistry:—

Constitution of the Blood in Various Diseases.

OBSERVERS.	DISEASES.	REMARKS.	No. of observations.	Day of disease.	No. of bleedings.	1000 PARTS OF BLOOD CONTAINED— Water.	Solid matters.	MOIST BLOOD-CORPUSCLES. Moist blood corpuscles.	Water.	Solid matters.	Albumen.	Solid matters of serum.	Fixed saline constituents.	Fibrin.
Becquerel & Rodier	TYPHOID FEVER	Mean	11	..	1	801.0	199.0	498.0	373.5	124.5	64.4	..	6.744	2.3
" "	"	Mean	11	..	2	814.5	185.5	454.0	340.5	113.5	62.0	..	6.555	1.3
Andral & Gavarret	"		..	5	1	756.3	243.7	581.2	435.9	145.3	..	96 1	..	2.3
" "	"		..	7	2	769.7	230.3	543.2	407.4	135.8	..	92.4	..	2.1
" "	"	Case 1	..	8	3	785.2	214.8	504.8	378.6	126.2	..	86.8	..	1.6
" "	"		..	10	4	798.6	201.4	464.8	348.6	116.2	..	83.9	..	1.3
" "	"		..	15	5	827.4	272.6	366.8	275.1	91.7	..	79.9	..	1.0
" "	"		..	7	1	766.5	233.5	574.4	430.8	143 6	..	87.4	..	2.5
" "	"	Case 2	..	9	2	777.6	222.4	544.8	408.6	136.2	..	82.5	..	3.7
" "	"		..	12	3	782.1	217.9	538.0	403.5	134.5	..	79.8	..	3.6
" "	"		..	8	1	767.6	232.4	557 2	417.9	139.3	..	88.1	..	5.0
" "	"		..	10	2	777.3	222.7	518.8	389.1	129.7	..	87.6	..	5.7
" "	"	Case 3	..	11	3	782.4	217.6	508.4	381.3	127.1	..	85.5	..	5.0
" "	"		..	14	4	791.7	208.3	494.4	370.8	123.6	..	80.7	..	4.0
" "	"		..	9	1	769.5	230.5	598.4	448.8	149.6	..	77.3	..	3.6
" "	"		..	10	2	784.7	215.3	501.2	375.9	125.3	..	87.1	..	2.9
" "	"	Case 4	..	12	3	804.3	195.7	494.8	371.1	123.7	..	69.7	..	2 3
" "	"		..	15	4	831.1	168.9	412.0	309.0	103.0	..	64.0	..	1.9
" "	"		..	33	5	845.5	154.5	318.4	238.8	79.6	..	71.2	..	3 7
" "	"		..	9	1	810.3	189.7	409.6	307.2	102.4	..	83.9	..	3.4
" "	"		..	10	2	816.2	183.8	420.0	315.0	105.0	..	79.8	..	3 5
" "	"	Case 5	..	12	3	825 6	174.4	375 6	271.7	93.9	..	78 2	..	2.3
" "	"		..	17	4	836.8	163.2	345.2	259.9	86.3	..	75.2	..	1.7
" "	"		..	24	5	847.8	152.2	304.0	228.0	76.0	..	74 6	..	2.1
" "	"	Case 6	..	1	1	819.7	180.3	372.4	278.3	93.1	..	86.3	..	0 9
" "	"	Case 7	..	5	1	752.9	247.1	586.7	440.0	146.7	..	98.0	..	2.4
" "	"	Maxima	41	..	..	862.3	243.7	598.4	448 8	149.6	..	98.0	..	4.2
" "	"	Minima	41	..	..	756.3	137.7	266.8	200.1	66.7	..	66.8	..	0.9
" "	"	Mean	41	..	..	796 0	204 0	464.0	348.0	116.0	..	77.9	..	2.6
Lecanu	"	.. ..	2	..	..	805.2	194.8	460.0	345.0	115.0	..	79.0	..	..
Simon	"	.. ..	1	..	..	792.3	207.6	419.2	314.4	104.8	80.33	..	..	2.01
Popp	"	Maxima	8	..	..	827.0	208 5	531.2	398.4	132.8	..	86.1	..	5.00
"	"	Minima	8	..	..	791 5	173.0	369.6	277.0	92.4	..	71.3	..	1.71
"	"	Mean	8	..	..	806.2	..	418.8	336.6	112.2	..	77 7	..	3.26
M. H. Guenaud de	TYPHUS FEVER	Male, Case 1	..	..	1	755.8	211 2	586.0	439.5	146.5	..	75.4	..	2.3
Mussy & M. Rodier	"	Male, Case 2	..	..	..	814.2	185.8	454.0	341.5	113.5	..	71.1	..	1.2

Constitution of the Blood in Various Diseases—Continued.

OBSERVERS.	DISEASES.	REMARKS.	No. of observations.	Day of disease.	No. of bleedings.	1000 PARTS OF BLOOD CONTAINED— Water.	Solid matters.	MOIST BLOOD-CORPUSCLES. Moist blood corpuscles.	MOIST BLOOD-CORPUSCLES. Water.	MOIST BLOOD-CORPUSCLES. Solid matters.	Albumen.	Solid matters of serum.	Fixed saline constituents.	Fibrin.
M. H. Guenaud de Mussy & M. Rodier	TYPHUS FEVER	Male, Case 3	..	..	..	799.0	201.0	452.4	314.3	138.1	..	60.1	..	2.8
" "	"	Male, Case 4	..	..	..	826.9	173.1	388.0	291.0	97.0	..	72.0	..	3.9
" "	"	Female, Case 5	..	..	..	800.7	199.3	507.2	380.4	126.8	..	70.0	..	2.5
" "	"	Female, Case 6	..	..	..	830.6	169.4	382.4	286.8	95.6	..	71.7	..	2.1
Becquerel & Rodier	EPHEMERAL FEVER (SIMPLE CONTINUED FEVER)	.. ..	8	..	..	781.6	218.4	569.6	427.2	142.4	65.7	..	5.8	2.8
Andral & Gavarret	SMALL-POX	Case 1	..	..	1	771.5	228.5	482.4	361.8	120.6	..	103.5	..	4.3
" "	"		..	..	2	780.8	219.2	440.8	330.6	110.2	..	106.1	..	2.9
" "	"		..	..	3	820.2	179.8	378.4	283.8	94.6	..	82.1	..	3.2
" "	"	Case 2	..	..	1	791.3	208.7	457.2	342.9	114.3	..	91.4	..	3.0
" "	"		..	..	2	803.9	196.1	370.4	277.8	92.6	..	100.3	..	3.2
" "	"		..	..	3	811.8	188.2	353.6	265.2	88.4	..	96.8	..	3.0
" "	"		..	..	4	817.3	182.7	348.0	261.0	87.0	..	92.4	..	3.3
" "	"	Case 3	..	..	1	781.4	218.6	511.6	383.7	127.9	..	88.1	..	2.6
" "	"		..	..	2	792.0	208.0	497.6	372.2	124.4	..	80.1	..	3.5
" "	"	Case 4	..	..	1	796.0	204.0	506.0	379.5	126.5	..	76.4	..	4.1
" "	"		..	..	2	792.7	207.3	499.6	374.7	124.9	..	80.4	..	2.0
" "	"	Case 5	..	..	1	805.0	195.0	395.2	296.4	98.8	..	92.3	..	2.9
" "	SCARLATINA	Case 1	..	..	1	761.5	238.5	584.0	438.0	146.0	..	89.4	..	3.1
" "	"		..	..	2	782.6	217.4	497.2	372.9	124.3	..	89.1	..	4.0
" "	"	Case 2	..	..	1	776.3	223.7	544.4	408.3	136.1	..	84.1	..	3.5
" "	"	Case 3	..	..	1	798.3	201.7	448.8	336.6	112.2	..	82.7	..	6.8
Lecanu	"	.. ..	..	..	..	776.5	223.5	578.0	433.5	144.5	..	78.9	..	..
"	"	.. ..	..	..	..	770.4	229.6	587.8	441.0	146.8	..	82.7	..	..
Andral & Gavarret	MEASLES	Case 1	..	..	1	760.2	239.8	586.4	439.8	146.6	..	90.6	..	2.6
" "	"	Case 2	..	..	1	766.9	233.1	563.6	422.7	140.9	..	89.2	..	3.0
" "	"	Case 3	..	..	1	781.6	218.4	548.4	411.3	137.1	..	78.7	..	2.6
" "	"	Case 4	..	..	1	786.7	213.3	550.0	412.5	137.5	..	73.4	..	2.5
" "	"		..	..	2	795.8	204.2	526.4	394.8	131.6	..	70.1	..	2.7
" "	"	Case 5	..	..	1	792.1	207.9	474.4	355.8	118.6	..	86.9	..	2.4
" "	"		..	..	2	823.8	176.8	373.2	279.9	93.3	..	80.1	..	3.4
Becquerel & Rodier	"	Man, Case 1	..	..	1	..	..	584.4	438.3	146.1	..	..	..	2.8
" "	"		..	..	2	..	..	506.4	379.8	126.6	..	..	..	3.8
" "	ACUTE SCURVY	Man aged 48	..	42	..	786.8	213.2	571.2	428.4	142.8	..	67.88	..	2.5
" "	"	Man aged 21	..	30	..	783.7	216.3	500.2	375.0	125.0	..	89.00	..	2.2
" "	CHRONIC SCURVY	Man aged 32	..	455	..	763.5	236.5	611.6	458.7	152.9	..	81.69	..	1.85

Constitution of the Blood in Various Diseases—Continued.

OBSERVERS.	DISEASES.	REMARKS.	No. of observations.	Day of disease.	No. of bleedings.	1000 PARTS OF BLOOD CONTAINED—								
						Water.	Solid matters.	MOIST BLOOD-CORPUSCLES.			Albumen.	Solid matters of serum.	Fixed saline constituents.	Fibrin.
								Moist blood corpuscles.	Water.	Solid matters.				
Becquerel & Rodier	CHRONIC SCURVY	Man aged 23, before treatment	..	552	..	765.9	234.1	704.8	528.6	176.2	..	56.59	..	1 32
" "	"	After treatment	..	612	..	778.0	222.0	542.8	407.1	135.7	..	84.02	..	1.14
Busk	"	.. ..	..	..	..	849.9	150.1	191.2	143.4	47.8	84.0	..	9.5	6.5
"	"	.. ..	..	..	..	835.9	164.1	289.2	206.9	72.3	76.6	..	11.5	4.5
"	"	.. ..	..	..	..	846.2	153.8	242.8	182.1	60.7	74.2	..	10.9	5.9
Popp	ERYSIPELAS	Male aged 33	..	..	..	807.9	192.1	511.2	383.4	127.8	57.6	..	..	6.6
Andral & Gavarret	"	Case 1	..	2	1	826.6	173.4	303.6	227.7	75.9	..	83.2	7.3	7.0
" "	"		..	3	2	836.0	164.0	257.6	193 2	64.4	..	87.3	6.2	6 1
" "	"	Case 2	..	2	1	799.2	200.8	433.6	325 2	108 4	..	78 9	6.8	6.7
" "	"		..	3	2	806.2	193 8	407.6	305.7	101.9	..	78.2	6.4	7.3
" "	"	Case 3	..	3	1	831.2	168.8	294.4	220.8	73.6	..	83.0	7.2	5.0
" "	"	Case 4	..	5	1	788.7	211.3	476.4	357.3	119.1	..	80.7	6.8	4.7
" "	"		..	8	2	796 9	203.1	442.8	332.1	110.7	..	80.5	6.9	5.0
" "	"	Case 5	..	3	1	762 9	230.4	557.6	418.2	139.4	..	80.2	7.2	3.6
Heller	"	.. ..	..	..	..	762.4	237.5	566.8	425.1	141.7	..	90.4	..	5.45
Wittstock	CHOLERA	.. ..	..	..	..	740.0	260.0	597.6	473.2	124.4	110.02	..	14.1	11.00
Simou	"	.. ..	..	..	..	750.5	249.4	434.0	325.5	108.5	114.1	..	10.6	2.47
"	"	.. ..	..	..	..	740 0	260.0	497.6	373.2	124.4	110.4	..	14.1	11.00
Becquerel & Rodier	"	Man, day of death	..	..	..	722.5	277.4	758.4	568.8	189.6	51.8	85.0	..	1.88
" "	"	" "	..	..	..	753.9	245.0	640.8	480.6	160.2	69 39	89.3	..	6.50
Popp	PHTHISIS	Male aged 22	..	..	..	806.2	193.8	495.2	371.4	123.8	..	65.5	..	4.06
"	"	Male aged 22	..	..	..	818.0	182.0	378.8	284.1	94.7	..	81.5	..	5.16
"	"	Male aged 22	..	..	..	786 9	213.1	502.0	376.5	125.5	..	85.9	..	1.864
"	"	Male aged 24	..	..	..	802.2	197.8	323.6	242.7	80.9	..	110.6	..	6.10
"	"	Female aged 26	..	..	..	791.5	208.5	502.4	376.8	125.6	..	80.5	..	2.30
"	"	Male aged 27	..	..	..	771.1	228.9	606.4	454.8	151.6	..	75.7	..	2.12
"	"	Male aged 36	..	..	..	819.0	181.0	306.4	229.8	76.6	..	100.9	..	3.29
"	"	Male aged 40	..	..	..	806.0	194.0	415.6	311.8	103.8	..	82.7	..	7.43
"	"	Male aged 39	..	..	..	845.8	154.2	274.0	205.5	68.5	..	80.2	..	5.30
Becquerel & Rodier	"	.. ..	16	..	1	794.8	205.2	500.0	375.0	125.0	66.2	..	..	4.80
" "	"	.. ..	16	..	2	799 8	200 2	490.8	367.2	122.7	65.0	..	..	4 20
" "	"	.. ..	16	..	3	821.0	179.0	414.0	310 5	103.5	62.0	..	..	3.60
Andral & Gavarret	"	Maxima	21	..	..	845.8	225 0	488.4	366.3	122.1	..	105.4	..	5.90
" "	"	Minima	21	..	..	775.0	154.2	306.8	230.1	76.7	..	65.1	..	2 10
" "	"	Mean	21	..	..	809.7	190.2	402 0	301.5	100.5	..	85.3	..	4.40
Glover	SCROFULA	Male	..	..	..	816.4	183.6	400.0	300.0	100.0	..	73.9	5.4	4.30

Constitution of the Blood in Various Diseases—Continued.

OBSERVERS.	DISEASES.	REMARKS.	No. of observations.	Day of disease.	No. of bleedings.	1000 PARTS OF BLOOD CONTAINED— Water.	Solid matters.	Moist Blood-Corpuscles. Moist blood corpuscles.	Moist Blood-Corpuscles. Water.	Moist Blood-Corpuscles. Solid matters.	Albumen.	Solid matters of serum.	Fixed saline constituents.	Fibrin.
Glover	Scrofula	Male	..	..	..	803.4	196.5	409.2	306.9	102.3	..	84.4	5.7	4.00
"	"	Male	..	..	..	790 0	210.0	478.0	358.5	119.5	..	80.4	6.6	3.50
"	"	Male	..	..	..	798.0	202.0	397.2	297.9	99.3	..	94.7	5.0	3.00
"	"	Male	..	..	..	776.1	223.8	532.0	399.0	133.0	..	83.3	6.5	1.44
"	"	Male	..	..	..	806.0	194.0	408.4	306 3	102.1	..	83.5	6.3	2.10
"	"	Male	..	..	..	764.0	233 9	561.6	421.2	140.4	..	84.7	6.8	4.00
"	"	Mean	..	..	..	791.9	208.0	469.2	351.9	117.3	..	81.3	6.2	3.13
"	"	Female	..	..	..	785.4	214.6	440.0	330.0	110.0	..	94.0	7.27	3.30
"	"	Female	..	..	..	824.2	175.8	410.0	307.5	102.5	..	61.1	6.5	4.70
"	"	Female	..	..	..	783.7	216.3	506.0	379.5	126.5	..	81.2	6.4	2.20
"	"	Mean	..	..	..	796.1	203.8	459.2	344.4	114.8	..	78.6	6.6	3.58
Heller	Carcinoma	.. ..	..	..	..	832.4	167.5	308.0	231 0	77.0	..	74.0	..	16.44
"	"	.. ..	..	..	..	864.0	136.0	227.6	170.7	56.9	..	75.8	..	3.30
"	"	.. ..	..	..	..	852.6	147.4	244.0	183.0	61.0	..	80.97	..	5 42
"	"	.. ..	..	..	..	859.5	140.4	232 0	174.0	58.0	..	78.0	..	4.42
"	"	.. ..	..	..	..	820.0	179.9	397.6	298.2	99.4	..	99.4	..	3.31
"	"	.. ..	..	..	..	809.9	194.0	416.0	302.0	104.0	..	84.9	..	5 10
"	"	.. ..	..	..	..	853.7	146.2	242.0	181.5	60.5	..	77.6	..	8.12
Becquerel & Rodier	Bright's Disease, Acute	Case 1	..	..	1	801.9	198.1	516.0	387.0	129.0	..	66.4	..	2.70
" "	" "		..	..	2	838.7	161.1	388.4	291.3	97.1	..	61.4	..	2.80
" "	" "	Case 2	..	..	2	811.4	188.6	515.2	386.4	128.8	..	55.5	..	4.30
" "	" "		..	..	3	807.3	192.7	492.4	369.3	123.1	..	64.4	..	5.20
" "	" "	Maxima	15	..	..	..	..	586.0	439.5	146.5	..	76.53	..	3.76
" "	" "	Minima	15	..	..	..	..	342.0	256.5	85.5	..	55.15	..	1.65
" "	" "	Mean	15	..	..	814.4	185.6	468.8	351.6	117.2	..	65.3	..	2.99
" "	Bright's Disease, Chronic	Maxima	13	..	..	..	..	546.4	409.8	136.6	..	78.8	..	6.50
" "	" "	Minima	13	..	..	..	..	209.2	146.9	52.3	..	55.5	..	2.59
" "	" "	Mean	13	..	..	832.6	167.4	432.0	324.0	108.0	..	63.9	..	4.34
" "	Chlorosis	.. ..	..	..	..	778.2	221.8	567.2	425.4	141.8	..	78.2	..	1.80
" "	"	.. ..	..	..	..	776.6	223.4	556.4	417.3	139.1	..	80.9	..	3.24
" "	"	.. ..	..	..	..	783.1	216.9	553.2	414.9	138 3	..	75.7	..	2.73
" "	"	Maxima	6	..	..	..	..	436.4	327.3	109.1	..	92.8	..	5.01
" "	"	Minima	6	..	..	..	..	181.2	135.9	45.3	..	74 1	..	3.06
" "	"	Mean	6	..	..	828.3	171.5	344.8	258.6	86.2	..	80.2	..	4.20
" "	Anemia	Maxima	10	..	..	..	..	436.0	327.0	109.0	..	88.1	..	5.82
" "	"	Minima	10	..	..	..	..	327.2	235.4	81.8	..	69.2	..	1.62
" "	"	Mean	10	..	..	822.4	177.6	400.4	300.3	100.1	..	73.7	..	3.72

Constitution of the Blood in Various Diseases—Continued.

OBSERVERS.	DISEASES.	REMARKS.	No. of observations.	Day of disease.	No. of bleedings.	1000 PARTS OF BLOOD CONTAINED— Water.	Solid matters.	MOIST BLOOD-CORPUSCLES. Moist blood-corpuscles.	Water.	Solid matters.	Albumen.	Solid matters of serum.	Fixed saline constituents.	Fibrin.
Popp	SIMPLE RHEUMATIC FEVER	Male aged 24	..	..	..	772 9	227.1	566.8	425.1	141.7	..	82.1	..	3.17
"	" "	Male aged 26	..	..	..	798.4	201.6	429.8	322.1	107.7	..	89.8	..	4 02
"	" "	Male aged 46	..	..	..	791.4	208.6	472.0	354.0	118.0	..	88.5	..	1.93
"	FEB. ARTHRITIC RHEUMATISM	Female aged 20	..	..	1	801.4	198.6	400.8	300.4	100.2	..	86 4	..	11.89
"	" "		..	..	2	816.1	183.9	308.4	231.3	77.1	..	93.7	..	12.97
"	" "	Female aged 20	..	..	1	802.3	197.7	463.6	347.7	115.9	..	75.9	..	5.76
"	" "		..	..	2	822.8	177.2	346.0	259.5	86.5	..	82.6	..	8.92
"	" "	Male aged 22	..	..	1	790.4	209.6	461.9	345.9	115.3	..	82.8	..	11.40
"	" "		..	..	2	817.2	182.8	394 4	295.8	98.6	..	76.1	..	7.91
"	" "		..	..	3	830.7	169.3	368.1	276.0	92.0	..	67.9	..	9.25
"	" "	Female aged 19	..	..	..	859.7	140.3	236.4	177.3	59.1	..	67.7	..	13.34
"	" "	Male aged 40	..	..	..	789.8	210.2	472.8	354.6	118.2	..	84.9	..	7.06
"	" "	Male aged 24	..	..	..	785.6	214.4	481.2	360.9	120.3	..	85.7	..	8.21
Andral & Gavarret	ACUTE RHEUMATISM	Maxima	43	..	..	839.6	160.4	520.0	390.0	130.0	..	104.8	..	10.20
" "	" "	Minima	43	..	..	771.6	228.4	280 4	210.3	70.1	..	76.9	..	2.80
" "	" "	Mean	43	..	..	805.4	194.6	404.0	303.0	101.0	..	86.0	..	6.70
" "	CHRONIC RHEUMATISM	Maxima	10	..	..	826.8	259 9	517.2	362.9	154.3	..	102.0	..	5.10
" "	" "	Minima	10	..	..	741.1	173.2	296.0	222.0	74.0	..	77.1	..	2.60
" "	" "	Mean	10	..	..	782.7	217.3	432.8	324.6	108.2	..	95.2	..	3.80
Becquerel & Rodier	PUERPERAL FEVER	Mean	4	..	..	791.0	209.0	563.6	422.7	140.9	..	61.2	..	6.76
Heller	" "	.. ..	..	..	..	833.8	165.1	332.0	254.5	77.5	..	77.4	6.00	5.16
Andral & Gavarret	PNEUMONIA	Case 1	..	2	1	818.0	182.0	445.2	333.9	111.3	..	66.7	..	4.00
" "	"		..	3	2	818.5	181.5	430.8	323.1	107.7	..	68.3	..	5.50
" "	"		..	5	3	820.9	179.1	404.4	303.3	101.1	..	71.5	..	6.50
" "	"		..	7	4	834.4	165.6	332.8	249.6	83.2	..	73.4	..	9.00
" "	"	Case 2	..	3	1	773.0	227.0	551.2	413.4	137.8	..	84.0	..	5.20
" "	"		..	4	2	782.3	217.7	502.0	376.5	125.5	..	84.9	..	7.30
" "	"		..	5	3	795.0	205.0	469.6	352.2	117.4	..	80.7	..	6.90
" "	"		..	6	4	800.4	199.6	446.0	334.5	111.5	..	80.6	..	8.00
" "	"	Case 3	..	4	1	781.5	218.5	519.2	389.4	129.8	..	83.2	..	5.50
" "	"		..	5	2	788.3	211.7	465 2	348.9	116.3	..	88.6	..	6.80
" "	"		..	9	3	823.9	176.1	382.8	287.1	95.7	..	74.0	..	6.40
" "	"	Maxima	..	..	..	834.4	229.5	551.2	413.4	137.8	..	95 2	..	10.50
" "	"	Minima	..	..	..	770.5	165.6	332 8	249.6	83 2	..	66.7	..	4.00
" "	"	Mean	..	..	..	799.0	201.0	456.4	342.3	114.1	..	81.0	..	7.30
Becquerel & Rodier	"	Mean	5	..	1	801.1	199.0	490.0	367.5	122.5	61.1	..	..	7.40
" "	"	Mean	5	..	2	808.0	192.0	455.6	341.7	113.9	59.7	..	..	6.30

Constitution of the Blood in Various Diseases—Continued.

OBSERVERS.	DISEASES.	REMARKS.	No. of observations.	Day of disease.	No. of bleedings.	1000 PARTS OF BLOOD CONTAINED— Water.	Solid matters.	Moist Blood Corpuscles. Moist blood corpuscles.	Moist Blood Corpuscles. Water.	Moist Blood Corpuscles. Solid matters.	Albumen.	Solid matters of serum.	Fixed saline constituents.	Fibrin.
Andral & Gavarret	Pleuritis	Case 1	..	..	1	802.6	197.4	429.6	322.2	107.4	..	85.0	..	5.0
" "	"		..	..	2	807.6	192.4	410.0	307.5	102.5	..	84.9	..	5.0
" "	"	Case 2	..	..	1	783.5	216.5	515.2	386.4	128.8	..	83.8	..	3.9
" "	"		..	..	2	780.3	219.7	475.6	336.7	118.9	..	95.0	..	5.8
" "	"	Case 3	..	..	1	783.0	217.0	541.6	406.2	135.4	..	78.1	..	3.4
" "	"		..	..	2	798.5	201.5	496.8	372.6	124.2	..	73.1	..	4.2
" "	"	.. ..	..	..	..	774.2	225.8	510.8	383.1	127.7	..	92.2	..	5.9
" "	"	.. ..	..	..	..	845.6	154.4	273.2	204.3	68.3	..	81.1	..	5.0
Becquerel & Rodier	"	Mean	5	..	..	798.6	201.4	481.6	361.2	120.4	65.4	..	..	6.1
Andral & Gavarret	Peritonitis	.. ..	..	..	..	787.2	212.8	491.2	368.4	122.8	..	84.5	..	5.5
" "	"	Case 2	..	..	1	822.9	177.1	353.2	264.9	88.3	..	83.4	..	5.4
" "	"		..	..	2	831.6	168.4	294.4	220.8	73.6	..	89.5	..	5.3
" "	"		..	..	3	851.0	149.0	242.0	189.5	60.5	..	84.9	..	3.6
" "	"	Case 3	..	..	1	789.4	210.6	480.0	360.0	120.0	..	86.8	..	3.8
" "	"		..	..	2	802.7	197.3	438.0	328.5	109.5	..	83.1	..	4.7
" "	"		..	..	3	813.5	186.5	401.2	300.9	100.3	..	80.1	..	6.1
" "	Angina Tonsillaris	Case 1	..	4	1	782.6	217.4	444.0	333.0	111.0	..	100.3	..	6.1
" "	" "		..	5	2	793.6	206.4	421.2	315.9	105.3	..	93.9	..	7.2
" "	" "	Case 2	..	6	1	777.9	222.1	504.0	378.0	126.0	..	90.7	..	5.4
" "	" "	Case 3	..	2	1	819.5	180.5	360.0	270.0	90.0	..	88.1	..	4.4
" "	" "		..	3	2	830.2	169.8	318.0	238.5	79.5	..	83.9	..	6.4
Becquerel & Rodier	Acute Bronchitis	Males, mean	4	..	..	793.7	206.3	516.8	387.6	129.2	64.9	..	..	4.8
" "	" "	Females, mean	4	..	..	803.4	196.6	451.2	335.9	115.3	68.8	..	..	3.5
Andral & Gavarret	" "	Case 1	..	..	1	763.3	236.7	595.2	446.4	148.8	80.6	..	..	7.3
" "	" "		..	..	2	793.6	206.4	440.8	330.6	110.2	86.9	..	..	9.3
Lecanu	Carditis	.. ..	..	..	..	821.0	178.9	405.2	303.9	101.3	..	77.5	..	..
"	"	.. ..	..	..	..	880.4	119.5	167.6	125.7	41.9	..	77.6	..	..
"	"	.. ..	..	..	..	807.2	192.7	385.2	288.8	96.3	..	96.3	..	..
"	"	.. ..	..	..	..	847.4	154.8	276.0	207.0	69.0	..	85.8	..	..
Becquerel & Rodier	Pericarditis	.. ..	..	..	1	831.0	169.0	420.0	315.0	105.0	53.0	..	..	2.3
" "	"	.. ..	..	..	3	847.0	153.0	312.0	234.0	78.0	60.4	..	..	3.4
Popp	Inflammation of Brain	Case 1	..	..	1	811.2	188.8	421.6	316.2	105.4	..	76.8	..	6.4
"	" "		..	..	2	797.5	203.5	454.0	340.5	113.5	..	82.4	..	6.3
"	Glanders	Case 1	..	..	1	823.5	176.5	428.8	321.6	107.2	..	62.8	..	6.37
"	"		..	..	2	822.0	178.0	457.6	343.2	114.4	..	53.0	..	10.48
"	Lead Poisoning	.. ..	..	..	..	822.5	177.5	338.0	253.5	84.5	..	86.7	..	6.13

The comparison of the character, progress, and duration of the diseases in those cases from which these observations were derived (so far as the records extended), with the character, progress, and duration of the cases of malarial fever observed and recorded by ourselves, and the comparison of the results of the chemical examination of the blood in various diseases (allowing due weight to the different methods employed by different observers) with the results of our chemical examination of the blood in malarial fever, have forced upon my mind the conclusion *that, so far as these observations extend, the colored blood-corpuscles are more uniformly and rapidly destroyed in severe cases of malarial fever than in any other acute disease.*

We would state, distinctly and unequivocally, that this statement applies only to those results of investigation which are now before the profession.

This department of pathological chemistry may, with truth, be said to be in the imperfect and undeveloped state of the embryo. We know little or nothing definitely concerning the changes of the blood in yellow fever, and in the states induced by numerous poisons; and our knowledge, in almost every instance, extends no further than the destruction, or undefined alteration, of one or the other constituent, and does not penetrate beyond the exterior physical and chemical changes, and reveal the relations of the substances destroyed or altered to the poisons, or substances resulting from the action of the poisons.

When not merely the facts of the destruction or alteration of the constituents of the blood in all diseases have been determined, but also the causes of their destruction and alterations, and the methods and results, chemical, physical, physiological, and pathological, have been definitely determined; then, and not till then, will it be possible to draw broad lines of distinction between diseases, based upon the chemical, and physical, and physiological, and pathological alterations of the blood. Nevertheless, the first step in the right direction is to perceive and appreciate the extent and bearing of the established facts, even though they be imperfect, and superficial, and meagre.

In comparing these results, it should be remembered that the individuals whose blood I examined were, as a general rule, stout, athletic seamen and laborers, who had never before been attacked by the malarial fever, and who had been exposed but a short time to the malarial poison.

This table further shows that in certain states of the system—as the cancerous and cachectic, and in such as are induced by long starvation, and exposure, and improper habits, and by hemorrhages, scurvy, and Bright's disease—the blood-corpuscles are greatly diminished. These results do not invalidate the conclusion that blood-corpuscles are most rapidly destroyed in severe attacks of malarial fever, because the destruction accomplished by the slow action of the causes inducing these states of the system required months or even years, whilst an equal or even greater destruction may take place in a few days or weeks in malarial fever.

We affirm, and our affirmation is borne out by the results here recorded, that the colored blood-corpuscles are diminished during the progress of all acute diseases. Andral & Gavarret have shown that the idea which they promulgated in their earliest researches, that the blood-corpuscles are increased in the earlier stages of typhoid fever, was erroneous, and arose from the fact that this disease most frequently attacks those whose blood is rich in colored blood-corpuscles. The suspension of the process of digestion, and the perversion and partial suspension of secretion and nutrition, and the rapid chemical changes and corresponding rapid metamorphosis of matter—the universal attendants, or rather phenomena, of acute diseases, must necessarily be attended by a destruction, to a greater or less extent, according to the severity of the disease, of one or all the constituents of the fluid which supplies the elements for secretion, nutrition, and chemical change.

These causes produce destruction of the colored blood-corpuscles in all acute diseases; but in malarial fever we have an increased destruction which cannot be referred to these causes.

We have before shown that the blood-corpuscles suffer profound alterations in the liver and spleen during the active stages of malarial fever; and, in attempting to account for the different degrees of destruction of the colored blood-corpuscles in different diseases, this fact leads us to institute an examination and comparison of the lesions of these organs in different diseases.

In typhoid fever, the spleen is almost always more or less altered in appearance. Its volume is augmented, in many cases, to three or four times the natural size, and the parenchyma reduced to a soft pulpy mass. The cases of typhoid fever in which the size of the spleen is most augmented, and the tissues most softened and broken down, are those which terminate most rapidly. In forty-six examinations of the bodies of those who had died with typhoid

fever, Louis found this organ in its natural condition only four times. This enlargement and softening of the spleen appear to be in typhoid, as well as in malarial fever, the result, not of inflammation, but of congestion. Whether this congestion be the result of disturbances in the circulatory apparatus and nervous system and contiguous organs, or of the direct action of the malarial or typhoid poisons upon the spleen, will be more fully discussed hereafter, and do not bear directly upon the question now under consideration.

This source of the destruction of the colored blood-corpuscles exists, then, in both typhoid and malarial fevers. The enlargement of the spleen, however, is greater in malarial fever. Whilst, therefore, there should be a destruction of colored blood-corpuscles in the spleen in both typhoid and malarial fevers, this destruction should be somewhat greater in the malarial spleen.

We will next compare the lesions of the liver in these diseases. So far as pathological investigations (which, it must be confessed, have been confined almost exclusively to the mere physical alterations of this organ, the color and consistence) extend, nothing has been discovered in the condition or secretion of the liver peculiar to typhoid fever.

According to Andral, the liver almost constantly presents a healthy appearance.

Louis[1] found slight softening in about one-half of the cases of typhoid fever examined by him. It is probable that the softening of the liver in these cases resulted from commencing decomposition.

Pathological investigations, then, indicate that the blood-corpuscles are not destroyed in the liver of typhoid fever, as they are in this organ during malarial fever.

Here, then, is a marked difference between typhoid and malarial fever, and the cause why the destruction of the colored blood-corpuscles is more rapid in the latter than in the former.

Dr. Gerhard,[2] in his observations upon typhus fever, states that the spleen was of the normal aspect in one-half the cases; in the other half it was softened, but not enlarged; and in one case out of five or six, enlarged and softened.

Dr. Jenner examined the spleen in thirty-four subjects above the

[1] Anatomical, Pathological, and Therapeutical Researches upon the Disease known under the names of Gastro-Enteritis, Putrid Adynamic, Ataxic and Typhoid Fever, by P. Ch. A. Louis, 2 vols. Paris, 1829.

[2] Am. Journ. of Med. Sci., Feb. 1837

age of fifteen, who died before the termination of the fourth week of the disease, and found the average weight to be seven ounces and five drachms.

According to the observations of Dr. John Reid, the weight of normal spleens ranges from 2187 to 3062 grains. It is evident that in these cases, reported by Dr. Jenner, the spleen was but slightly, if at all, enlarged.

Dr. John Home examined after death one hundred and one cases of typhus fever, and found that the spleen was generally larger than usual, soft, and in some cases almost diffluent. In one instance this organ weighed eleven, and in another fourteen, ounces.

These observations, together with those of many other investigators, demonstrate that the lesions of the spleen are neither constant nor of any great extent. In some cases of typhus fever the liver has been found engorged with dark fluid blood, in others spotted with ecchymosis, and in many cases it was the seat of no appreciable lesion.

All observers agree that one of the most striking facts in the pathological anatomy of typhus fever, is the absence of any constant and characteristic lesions. The most uniform and important alteration appears to be that of the blood, which is manifested not only in its appearance, physical properties, and chemical constitution, but also in the rapidity with which the color of the skin changes after death, and the body undergoes decomposition, and the frequent occurrence of cold abscesses in various parts of the body after an attack of typhus fever.

If there be no destruction of the blood-corpuscles, independent of the liver and spleen in typhus fever, or if the destruction of the blood-corpuscles in the bloodvessels and capillaries, independent of the spleen and liver, be not more rapid in typhus than in typhoid and malarial fever, then the destruction of the colored blood-corpuscles should be less rapid in typhus fever than in typhoid and malarial fever. The observations thus far recorded do not enable us to settle this question definitely, for the patients from whom the blood was abstracted (the analyses of which are recorded in the table) were hospital patients, natives of Ireland, whose disease appeared (from the accounts of the authors) to have been aggravated by previous want. We know that this fever most frequently attacks those whose constitutions have been worn down, and their solids and fluids, especially the blood deranged by foul air and poor diet.

In malarial fever, and in fevers generally, the fibrin is rarely increased, and either remains within the limits of health, or is diminished, and, as far as my observations extend, the diminution of fibrin corresponds with the severity of the disease.

This fact corresponds with the results established by Andral in his splendid researches upon the blood.

The distinction between the alterations of the blood in the pyrexiæ and phlegmasiæ is thus pointed out by Andral:—

"In my first memoir upon the alterations of the blood I have proved that the fibrin never augments in the pyrexiæ, supposing them divested of all phlegmasial complication; that it often remains in normal quantity, and that sometimes it diminishes to a point at which we do not find it in any other acute disease. I have shown that the pustules of variola, and the dothinenteric plaques of typhoid fever do not have the power of increasing the cipher of fibrin; and finally I have shown that with all the possible proportions of the globules, whether they were very abundant, or whether they have become very rare, a pyrexia could equally arise with all its varieties of form and gravity. But is it indifferently, and as it were by chance, that the fibrin shows itself in the pyrexiæ, either in normal quantity, or in a proportion infinitely more feeble than in the physiological condition? No, without doubt, and with regard to this, very clear general principles may be laid down.

"At every period of clinical observation, and upon whatever point of view the observer was placed, it has been recognized that amongst the pyrexiæ there were some unattended by any grave symptoms, which marched naturally towards a favorable termination; while there were others which, either at their commencement, or during their course, were accompanied by accidents of such a nature, that it seemed as though the forces which rule the organism were either vanquished, or profoundly disordered to such an extent that the extinction of life must be the consequence; and at the same time it was found that in such cases the blood presented an altogether peculiar appearance; it was observed that as it became less consistent, it seemed to tend towards a sort of dissolution.

"Admitted at all periods, but differently explained according to the prevailing theories, this condition, which may develop itself in any pyrexia, and towards which several seem to tend naturally, has been called, turn by turn, putrid, adynamic, and typhoid state; it has its greatest development in the typhus fevers, properly so called; it is in some sort inherent in them; it is, as it were, their

essence. The pyrexia, now called typhoid fever, presents it in a slight degree from the invasion, and the grave cases of this disease are its marked representation. It does not ordinarily exist in the eruptive fevers, but it often complicates them, and constitutes one of their dangers. Finally, in addition to the pyrexiæ, with well-marked characters, and which have a fully developed place in nosological systems, there are others to which no name has been given, which may yet present in a high degree the different symptoms to which the ancients attached the idea of the putrid state. This is because there may exist in effect, in all the pyrexiæ, a common alteration of which the blood is the seat, and whose existence constantly coincides with the appearance of those phenomena always the same, attributed by vitalism to adynamia, by solidism to relaxation of the fibre, and by humorism to putridity of the humors.

"This alteration of the blood consists of a diminution of its fibrin. It is consequently an alteration the inverse of that which betrays in the blood the phlegmasial condition." * * *

"Since the diminution of the fibrin does not exist necessarily in any pyrexia, it is perfectly clear that it is not in this alteration of the blood that we should place the point of departure of this class of diseases. But what seems to me incontestable is, that the specific cause which gives them birth acts upon the blood in such a way that it tends to destroy its spontaneously coagulable matter, while the cause which produces the phlegmasiæ tends, on the contrary, to create in that fluid a fresh proportion of that matter. If this cause act with slight energy, or if the economy resist it, the destruction of the fibrin is not accomplished. If, on the contrary, the cause continue to act with all its intensity, and the forces of the organism be in fault, the destruction of the fibrin will commence either at the very beginning of the disease—which is very rare—or at a certain period after its commencement. All this applies itself equally well both to typhoid fever, and to the eruptive fevers.

"For me, there is in all these cases a true intoxication; if it be slight, its effect must, to be sure, always exist, but it is not appreciable; if the intoxication be stronger, the effect which it has produced upon the blood becomes visible, and is marked, in that fluid, by a diminution of the fibrin.

"Whilst, then, we establish, in certain forms of typhoid fever or scarlatina, that alteration of the blood which consists in a tendency to the destruction of its spontaneously coagulable matter, we no more attain by this means the true cause of the disease, than we do

by studying the alterations of which the tegumentary membranes are the seat. But, as these alterations of the mucous membrane or of the skin, once produced, bear their part in the production of symptoms, just so does the peculiar alteration of the blood which may then arise bear its part."[1]

With this quotation, confirmatory in a great measure of our own views, we close the examination of the nature and extent of the changes of the blood in malarial fever; not because we have by any means exhausted the subject, or even pointed out the full bearing of all the facts established by our own investigations, but because we are disinclined to pursue a subject so imperfectly investigated and developed; because we wish to avoid unprofitable discussions, which may be overturned by the first investigator who shall penetrate beneath the surface, or may lead to the adoption of erroneous principles of practice. We candidly confess that the unknown vastly exceeds the known, and that the great body of facts in this branch of pathological chemistry, are only surface facts, relating to the most superficial, exterior phenomena, and not to the relations and causes of phenomena.

After we have established that the blood-corpuscles, and the fibrin, and the saline matters of the blood in malarial fever, or in any other fever, have been destroyed or altered, questions of great importance immediately arise. How are they destroyed? Are they destroyed by an actual, direct physical and chemical action of a special poison, or by the suspension of the functions of the organ or organs in which they are born, or by the chemical and physical changes of the liquor sanguinis in which they float? What are the physical and chemical changes which the elements of the blood and organs and apparatuses undergo, under the action of morbific agents?

The imperfection of pathological chemistry is strikingly shown in the state of our knowledge with reference to the fixed saline constituents of the blood-corpuscles and liquor sanguinis. Notwithstanding the brilliant researches of Becquerel, Rodier, and others, we still need, amongst many other things, a comprehensive and laborious investigation of the changes of the saline constituents of the blood-corpuscles and liquor sanguinis. It is not sufficient that the saline constituents of the entire blood, or of the liquor san-

[1] An Essay on the Blood in Diseases, by G. Andral. Translated by J. F. Meigs, M. D., and Alfred Stillé, M. D. Philadelphia, 1844.

guinis, should be examined. The advancement of medical science demands that the relations between the fixed saline constituents of the blood-corpuscles and liquor sanguinis should be determined; demands that the variations and relations of the fixed saline constituents of every element of the blood should be determined in health and in disease.

An important question now presents itself.

Do these changes of the blood precede, or succeed, or are they simultaneous with, the aberration of the physical, chemical, vital, and nervous phenomena denominated fever?

This question can be settled only by an appeal to nature. I have resided almost all my life in a malarious district, in the southern part of Georgia, and speak from observation.

It is known to practitioners in malarious districts, that the constitution is sometimes undermined silently by the malarial poison, without the manifestation of febrile phenomena sufficiently marked to attract the attention of the patient or his friends. It is further known to the practitioners in our southern States, that the phlegmasiæ, especially pneumonia and pleurisy, and even the irritative fever succeeding amputations and severe wounds, will assume the intermittent, remittent, and even congestive types of malarial fever. That these types of inflammatory fevers are due to a state of the system permanently induced by the malarial poison, and also to the direct action of the poison during the inflammatory disease, is conclusively demonstrated by the mode of treatment most successful in these districts, and by the comparison of the results of this practice with that of healthy, non-malarious districts.

It is an established fact, that bleeding and active purgation will not be borne in the pneumonia and pleurisy of malarious districts as well as in these diseases occurring in the primitive, non-malarious, middle regions of Georgia and other States. It is an established rule with many practitioners in the malarious districts of our southern States, to avoid large bleedings and active purgation in pneumonia and pleurisy, whilst the reverse rule has prevailed in non-malarious districts, having the same climate and relations to heat and moisture.

It is known that the sulphate of quinia may be used with the greatest benefit and success in the treatment of pneumonia and pleurisy, and of the phlegmasiæ generally, and even of the irritative fever following amputations and severe wounds, in malarious dis-

tricts; whilst no such beneficial effects attend the use of this remedy in these diseases occurring in non-malarious districts.

These facts demonstrate that the malarial poison is capable of altering the constitution of the solids and fluids, and modifying and altering the type and progress, phenomena and effects, of diseases, even when no symptoms of aberrated physical, chemical, vital, and nervous actions were manifested, sufficient to attract the attention.

The author has carefully noted the antecedents of three attacks of malarial fever in his own person, occurring within eighteen months, and separated from each other by intervals of perfect health. The first was an attack of bilious remittent fever, contracted in a malarious district, during repeated exposure to the night air at late hours of the night, and aggravated by exposure to the hot sun in the early part of August.

For two weeks before the supervention of fever, the complexion assumed a sallow appearance evident to observers. The only unusual sensations at this time were those of irritability and excitement of the nervous system. In this state, there appeared to be an increase rather than a diminution of mental and physical force, and I was surprised to find the strength sufficient for twelve hours of hard labor in the conduction of pathological, physiological, and chemical investigations, and hospital practice, notwithstanding that the rest at night was exceedingly imperfect. Several days before the commencement of the fever, the bowels were deranged; the discharges were copious and frequent, and appeared to contain much altered bile, resembling that so often found in the gall-bladder of the malarial liver after death. Notwithstanding the supervention of this affection of the bowels, I was able to continue for three days, during the usual time (twelve hours daily), pathological investigations and hospital practice. The fever which followed was high; full rapid pulse, full moderately-accelerated respiration, high temperature, dry skin, dry tongue, high-colored urine, and, at one time, aberration of the intellect, preceded by intense pain in the head, and cold extremities.

The fever yielded readily to the action of the sulphate of quinia, and, shortly after its removal, I recommenced my labors; and, notwithstanding frequent exposure to the night air at all hours, perfect health was enjoyed for two months, at the end of which time I was troubled by periodical headaches, attended with derangement of digestion, the generation of much acid in the stomach, and high-colored urine, and, at times, with slight exacerbation of the pulse,

and slight increase of temperature. There was never any chill, nor anything approaching to a chill, either at the commencement or during the continuance of these periodical disturbances of the system, which returned every seven, nine, eleven, or fifteen days, and lasted from twelve to forty hours. The headaches appeared to be often relieved, and always benefited, by the free administration of the bicarbonate of potassa. It was frequently noticed that uric acid and urate of soda were deposited in the urine excreted just after the disappearance of the headache.

During the winter, I took up my residence in the town of Athens, situated upon the granite and gneiss hills of middle Georgia. The town and environs of Athens are without a single source of malaria, and its bills of mortality, and the appearance of its inhabitants, and the exemption of the students attending the University of Georgia from disease, show that it is one of the healthiest localities in the world.

In this healthy locality, contrary to expectation, the headache increased in severity, and the strength of the muscular system diminished, and the nervous system became more excitable, and the person lost flesh.

Up to the first of March, six months from the commencement of the periodical disturbances of the system, I had never been incapacitated a single day for the regular discharge of my professorial duties and investigations. At this time, after unusual anxiety and fatigue, a chill came on, in the evening of the day previous to the anticipated headache. During this chill the pulse was rapid, but feeble, the respiration was accelerated, full, and labored, the muscles trembled and shook, and the temperature of the extremities was many degrees below the normal standard, whilst the temperature of the trunk was elevated several degrees above the usual point of health. As we shall hereafter show, these were the phenomena of a true malarial chill.

The succeeding hot stage was well marked by a full, rapid pulse, rapid respiration, and corresponding equalization and elevation of the temperature of the trunk and extremities, and by suppression of the secretions of the mucous membrane of the tongue and mouth, loss of appetite, derangement of digestion, severe pain in the head, and high-colored, strongly acid urine.

Thinking that it was not only improbable, but impossible, that chill and fever could arise in Athens, and failing to infer the connection of the periodic disturbances with the operation of malaria

(because, up to the present time, they had never been attended by a well-marked chill and febrile excitement), I neglected to use the sulphate of quinia. After the intermission of one week, the chill and fever returned with increased violence. The free administration of the sulphate of quinia after this paroxysm, prevented a subsequent return, and, with the disappearance of the chill and fever, the headaches vanished, and I have been free from them to the present time, one year.

Several of the students who had resided in malarious districts, previous to their residence in Athens, were attacked with intermittent fever, which, previous to the attack, appeared to have destroyed, to a considerable extent, the colored blood-corpuscles. I examined these cases, and inquired into their previous history carefully, and am convinced that they were genuine cases of malarial fever, induced by the action of a poison which had been received into the system months previous to their residence in this healthy climate and locality. The third attack from which I suffered, was contracted during a visit to the swamps of Georgia, in the month of September. Although much more severe than the two which I have recorded, the preceding symptoms did not differ essentially from those of the first attack, with the exception, that there was no affection of the bowels preceding the fever.

These cases demonstrate conclusively that the malarial poison can exist in the system, and induce slow alterations in the blood, without the appearance of those phenomena characteristic of fever, and without any marked aberration of nervous action.

Many other facts might be brought forward to support this statement. Thus the serum of the blistered surfaces, in all the stages from the beginning to the end of severe cases of malarial fever, has always (as far as my observations extend) presented a golden-yellow color. Post-mortem examinations have revealed the fact that the livers of those residing in malarious districts have presented the peculiar slate and bronze color, although the patients had, at no previous time, manifested the phenomena of fever. The spleen of a large stout man, who was seized suddenly with coma whilst exposed to the malarial influence on the Savannah River, and who died after forty-three hours' sickness, was enlarged, softened, and of a slate color; the liver was changed to the slate and bronze color in several places, and the bile was concentrated and of a brownish-black color, with greenish reflections, and poured like molasses. Under the microscope the colored corpuscles of the splenic mud appeared

swollen and altered; the solitary glands of the intestines were enlarged; and the heart contained a fibrous clot. In this case the changes were at least simultaneous with the manifest disturbances of the physical, chemical, vital, and nervous phenomena.

Dr. Stevens[1] ascertained that in the marsh fevers, both of America and of the West Indies, the blood is diseased before the attack; it was found to be dark in color, and evidently deranged in its physical properties; its serum, instead of being translucent, presented a muddy or brown color, and sometimes an oily appearance. During this altered state of the blood, previous to its effects upon the nervous system, by which alone the patient would be aware that the healthy functions of the body were disturbed, the temperature of the body would frequently be reduced several degrees below the normal standard, and the pulse becomes less frequent. It has been asserted that the seasoning fever of the West Indies (endemic yellow fever) is preceded by a morbid condition of the blood.

Dr. Ch. W. Ball[2] observed that whilst the fainting fever of Persia was at its height in Teheran, the blood, even of those not sensibly attacked, presented a dark, dusky, reddish-brown color, very different from that of healthy venous blood; and that in general the serum did not separate from the clot.

Dr. John Mitchell,[3] of Virginia, Salvagnoli, Dr. Archer,[4] of Norfolk, and Dr. Porter, of Baltimore, and others, have recorded similar observations with reference to the changes of the blood previous to the manifestation of aberrated nervous action.

Dr. Potter,[5] in the fever which prevailed in Baltimore in 1800, demonstrated this fact conclusively by the following examinations: "To ascertain the appearance of the blood in good health, I drew it from five persons who had lived, during the whole season, in the infected parts of the city, who were in every external appearance and inward feeling in perfect health. The appearance of the blood could not be distinguished from that of those who labored under the most inveterate grades of the disease. A young gentleman having returned from the western part of Pennsylvania on the 10th of September in good health, I drew a few ounces of blood from a vein on that day; it discovered no deviation from that of other

[1] Stevens on the Blood, pp. 214–219.

[2] British and Foreign Med. Rev., xvi. p. 521.

[3] Medical and Philos. Register, vol. iv. p. 188.

[4] History of the Yellow Fever of Norfolk in 1821, Med. Recorder, vol. v. p. 68.

[5] A Memoir on Contagion, p. 54.

healthy persons. He remained in my family till the 26th of the month, and on that day I repeated the bloodletting. The serum had assumed a deep yellow hue, and a copious precipitate of red globules had fallen to the bottom of the receiving vessel."

CHAPTER V.

CHANGES OF THE ORGANS, AND TISSUES, AND APPARATUS OF THE BODIES OF THOSE WHO HAVE DIED WITH THE DIFFERENT TYPES OF MALARIAL FEVER, INTERMITTENT, REMITTENT, AND CONGESTIVE—COMPARISON OF THESE CHANGES WITH THE PHENOMENA OF MALARIAL FEVER, AND WITH SIMILAR CHANGES IN OTHER DISEASES, AND WITH THE ORGANS, TISSUES, AND APPARATUS OF MEN AND ANIMALS IN THE NORMAL CONDITION.

Exterior skin—Muscular system. Head—dura-mater, arachnoid membrane, pia-mater, cerebrum, cerebellum, medulla oblongata, ventricles of brain, &c. Nervous phenomena of fever, compared with post-mortem examinations. Chest—Lungs, heart. Alimentary and intestinal canal—Mouth, tongue, œsophagus, stomach, duodenum, jejunum, ileum, colon, rectum, glands of Peyer, solitary glands. Liver—Slate and bronze color of liver; changes of blood of liver; malarial liver contains animal starch, but no hepatic sugar; bile. Spleen—Slate color of spleen; pulp of spleen; alterations of structure. Kidneys—Supra-renal capsules. Bladder.

THE following observations are based upon a careful examination and comparison of the symptoms of three hundred cases of malarial fever; fifteen post-mortem examinations of the bodies of those who had died from the different types of malarial fever, intermittent, remittent, and congestive; numerous examinations of the bodies of those who had died from various diseases, as phthisis pulmonalis, pneumonia, pleurisy, dysentery, diarrhœa, cirrhosis of the liver, fatty degeneration of the liver, dropsy, hemorrhage, apoplexy, cancer, intemperance, scarlet fever, diabetes, Bright's disease, enlargement of the lymphatic glands, typhoid fever, and yellow fever, and upon the careful dissection and microscopical examination of the organs, tissues, and apparatus of several hundred fishes, reptiles, birds, and mammalia.

Exterior.—In the severe cases of malarial fever, which terminate in a short time, the muscular system, and the fat surrounding the muscles, did not appear reduced to any great extent. In cases of

long standing, especially those which had been neglected, there was great loss of flesh and fat, and the body and limbs presented an emaciated appearance, unless the tissues were infiltrated with serum. As a general rule the cadaverous rigidity was well marked.

In many cases the surface presented a sallow hue; and in one violent case of congestive fever, several hours before death, as the patient lay in a profound stupor, the whole surface assumed a golden yellow color, similar to that of the serum which issued from a blistered surface over his epigastrium.

In the majority of cases, the color of the skin of the superior parts, after death, presented a pale, bloodless appearance; whilst the skin of the inferior (dependent) portions presented a mottled purplish color. This dark purplish color of the dependent parts gradually diminished towards the superior uppermost parts of the body in the recumbent posture, and appeared in every instance to have been due to the gradual settling of the blood in the capillaries of the most dependent parts towards the close of life, when the general and capillary circulations were feeble. For this reason the lips and gums were almost always pale, and almost white. The lungs, and liver, and kidneys, and intestines, and stomach, and brain in many, if not in every case, presented similar evidences of the gradual settling of the blood in the vessels and capillaries of the most dependent parts towards the close of life, when the feeble circulation was readily overcome by the force of gravitation. If stimulants and sinapisms had been freely used in the last hours, the settling of the blood in the most dependent parts was not so marked.

Cerebro-Spinal Nervous System.

As far as my observations have extended, in malarial fever the dura mater was always normal—the arachnoid membrane pearl-colored, opalescent in some cases, in others perfectly transparent and normal in appearance—the bloodvessels of the pia mater congested with blood, but always without any marks of inflammation; subarachnoid fluid in almost all cases clear, and transparent, and in one or two cases colored by the presence of colored corpuscles; in severe cases of a golden color; the amount varied in different cases, sometimes exceeding, but most generally falling short of the usual amount—the bloodvessels of the brain generally filled with blood—structures of the brain appeared in almost every case normal, altered neither in consistency nor appearance; blood was effused upon the brain in only two instances.

The opalescent pearl color of the arachnoid membrane in spots, was of little diagnostic value, because it was by no means uniform. In like manner, the variations in the amount of the subarachnoid fluid and cerebro-spinal fluid was of little diagnostic value, because its chief use is mechanical, and Magendie has shown that it can be rapidly secreted and rapidly absorbed without any disturbance of the functions of the brain; and further, that even in the normal condition it varies greatly in amount, from two drachms to two ounces; and Cotunnius, the original discoverer of this fluid, states that in experiments upon the bodies of twenty adults, the amount of this fluid varied from four to five ounces.

In asserting that the structures of the brain in malarial fever were, as a general rule, altered neither in consistence nor in appearance, we do so only upon the evidence afforded by sight and touch; we do therefore by no means affirm this to be a fact established upon an immutable basis. How difficult is it to prove the mode of action of the malarial poison upon the nervous system, especially when it may act in a manner analogous to that of certain violent poisons, which we know will occasion almost instantaneous death, without producing a single pathological alteration recognizable by the most delicate chemical tests, or the most rigid microscopical examination. We know that some substances, as chloroform, will produce sudden death, in some cases, where there is no assignable cause, either in the structures or forces of the patient, or in the pathological alterations produced, or in its accustomed action. This peculiar action is said to be due to the idiosyncrasy of the patient. May not the fatal action of the malarial poison be due, in some cases, to the idiosyncrasy of the patient? The question is, What is an idiosyncrasy? No one has ever demonstrated whether these peculiarities of constitution depend upon the physical and chemical structures and relations of the solids and fluids, or upon the relations of the physical, chemical, vital, nervous, and muscular forces, or upon both sets of relations combined. We must admit that to determine accurately the alterations of the nervous apparatus, under the action of various morbific and remedial agents, it is absolutely necessary that the structures of the different parts of the nervous apparatus should be submitted to a rigid chemical and microscopical analysis. Numberless insuperable difficulties lie in the way of complete microscopical and chemical analyses. It is impossible to obtain the substances for analysis until several hours after death, and, in substances so liable to change, important altera-

tions may take place, even in this short time. It is impossible to separate the blood entirely from the nervous elements; and the presence of a varying amount of blood, of varying constitution, would of itself be sufficient to vitiate the results of every analysis which had for its object the determination of the chemical changes induced by a most subtle poison. Notwithstanding this imperfect state of pathological science; notwithstanding that we have no facts to warrant the assertion that the malarial poison acts primarily or exclusively upon one system of nerves or the other; we should, nevertheless, analyze the phenomena as far as our means of analysis extend, and use all the well established facts to the extent of their bearing and significance. We will proceed to do this.

As far as my observations extend, the pathological alterations of the structures of the brain and spinal marrow do not correspond to the symptoms during life. The most universal phenomenon appears to be the stagnation and accumulation of the blood in the blood-vessels and capillaries of the brain and pia mater. This accumulation of the blood in the vessels of the brain and pia mater appears to be due neither to inflammation nor to irritation, but simply to a stagnation of the blood, similar to the stagnation and accumulation of the blood in the vessels of the large organs.

This view is conclusively sustained by the results of treatment. In numerous cases I have seen the wildest delirium calmed, the intellect aroused into full vigor from the most profound coma, and the most alarming cerebral symptoms vanish under the free use of stimulants and sinapisms, with or without the sulphate of quinia. When the sulphate of quinia was withheld, the effects of the stimulants and sinapisms would be but temporary; whilst, when it was administered in sufficient quantities, the restoration of the intellectual functions and the removal of the cerebral symptoms were permanent. Now, is this the action of stimulants or of sulphate of quinia upon an irritated or inflamed brain? *These facts alone demonstrate conclusively that the cerebro-spinal system is not the seat of irritation or inflammation in malarial fever, if we limit irritation and inflammation to the meaning universally adopted; and that if irritation and inflammation of the cerebro-spinal system do arise in the progress of malarial fever, they are by no means universal phenomena dependent upon the definite and universal action of the malarial poison.*

To what, then, must we refer the aberrated nervous phenomena of malarial fever? Whilst we cannot answer this question fully and absolutely in the present imperfect, undeveloped state of phy-

siology and pathology, we can point out and demonstrate three distinct causes: 1st, the alterations of the blood; 2d, the disturbances of the general and capillary circulations; and 3d, the direct depressing effects of the malarial poison upon the nervous apparatus.

1st. *The Altered Blood.*—We have shown in the preceding chapter that the colored blood-corpuscles are not only greatly and rapidly diminished in malarial fever, but that they often lose the saline constituents. We have every reason to believe that the blood-corpuscles, taken collectively, perform the offices of an immense gland for the elaboration of the materials for the nutrition of the muscular and nervous systems. We have further shown that the coloring matters of the serum are increased, and the coloring matters of the bile retained, in the blood of malarial fever. And I shall hereafter show that the constitution of the urine is greatly altered in the severest forms of malarial fever, and that some of its most important constituents are either not formed at all, or, if formed, are not eliminated. We have also shown that the fibrin is altered both in quantity and in quality.

Here, then, we have profound alterations of the blood which must induce corresponding disturbances in the muscular and nervous systems, and in all the organs and tissues which derive their nutrition from the blood. Here, then, we have profound alterations in the constituents of the blood which must produce corresponding disturbances in the general and capillary circulations, and in the chemical changes in the capillaries and surrounding tissues upon which depend the capillary circulation, and, in fact, the development and maintenance of all the forces—physical, muscular, and nervous.

As a general rule, the general and capillary circulations are greatly disturbed in congestive fever. These disturbances are manifested in the quick, thumping action of the heart, the small, feeble, rapid pulse, the panting, full respiration, the want of correspondence between the temperatures of the trunk and extremities, the aberration of the physical, chemical, muscular, and nervous phenomena, and in the stagnation of the blood in the different organs and tissues. The stagnation of the blood in the organs, tissues, and apparatus, is due to disturbances in the sympathetic and cerebro-spinal system, disturbances in the general circulation, disturbances in the quantities and qualities of the constituents of the blood, and arrest or perversion of the chemical changes of the capillaries. It is well established that the circulation of the blood through the

capillaries depends upon the relations, quantitative and qualitative, physical and chemical, of the individual constituents of the blood to each other, and to the capillaries and the surrounding tissues, and that disturbances of their relations will be attended by arrest of the capillary circulation, and stagnation and congestion of the blood, notwithstanding that the general circulatory apparatus may receive a sufficient supply of nervous force, and perform its offices with sufficient vigor.

When the general circulation is impeded, either by the direct action of the malarial poison, or of the altered blood upon the fibres of the heart, or by the withdrawal or perversion of the nervous force supplied by the sympathetic nervous system, or by the cerebro-spinal nervous system, through the sympathetic, consequent upon the action of the altered blood, or of the malarial poison, or of both: it follows, as a necessary consequence, that the introduction and distribution of oxygen will be retarded, and the chemical changes in the capillaries will be impeded, and the blood will stagnate and accumulate in the capillaries.

We have before demonstrated that chemical change is necessary for the development of muscular and nervous force, and for the manifestation of intellectual phenomena. Whenever, therefore, the normal chemical actions of the blood are disturbed, aberrated nervous action, both in the cerebro-spinal and sympathetic nervous systems, must result.

We have a striking confirmation of these views in the mode of origin and progress of the phenomena called *chill* in malarial fever.

The poison, as we have before demonstrated in the chapter on the blood, first alters the constitution of the blood, and interferes with the actions and secretions of those organs which elaborate the blood, before producing any perceptible changes in the phenomena of either the sympathetic or cerebro-spinal nervous systems; this alteration of the blood progresses until a point is reached, where either such compounds are generated in the cycle of chemical changes, induced by the malarial poison, or the constituents of the blood, especially the colored blood-corpuscles and fibrin, become so altered that disturbances are produced in the chemical changes by which the capillary circulation is maintained, and as a necessary consequence the action of the heart, which depends, as all other muscular actions do, upon the chemical changes in the capillaries, is impeded, and the blood gradually stagnates in the capillaries, and accumulates in the large bloodvessels of the trunk and internal organs, and the temperature of the extremities, due to the chemical changes of the blood in the capillaries and

the surrounding tissues, sinks far below the normal standard; this arrest of the capillary circulation in the extremities, and probably also in the lungs, is attended by the retention of the products of excretion, as carbonic acid, and the matters thrown off from the skin and kidneys; these excrementitious offending matters, together with the products resulting from the perverted chemical changes, due in part to the reduction of the temperature of the extremities many degrees below the normal standard, stimulate the sympathetic and cerebro-spinal nervous system; the sensation of cold is felt, attended by twitching and jumping of the muscles, entirely beyond the control of the will, because they are due to aberrated muscular and nervous action, arising from disturbances in the capillary circulation, and from the action of the perverted elements of the blood; the respiration is aroused, more oxygen is introduced, and the temperature of the trunk elevated, provided the alterations in the constitution of the blood have not proceeded too far, or the nervous system been so overwhelmed, either by the action of the altered products, or of the malarial poison, that they cannot respond to the excitation produced by the altered and retained productions; the elevation of the temperature of the trunk is attended by a more rapid circulation of the blood in the capillaries of the heart and of the nervous centres, and consequently by a more rapid and powerful action of the heart and generation of nervous force; the oxygen is introduced and distributed with greater rapidity, the chemical changes in the capillaries are again excited, the capillary circulation is first restored in the trunk and then in the extremities, the elevation of temperature becomes general, and we have the phenomena called fever.

During the active chemical changes of fever, the malarial poison and the altered products of the blood are drawn into the round of chemical change, physically and chemically altered, and are finally thrown off from the lungs, skin, kidneys, and intestinal canal. After the removal of these offending products, the excitants of the sympathetic and cerebro-spinal nervous system, after the system has been purified, as if by fire; then the nervous system returns back to the normal exercise of its functions; the force and frequency of the heart diminish; the panting, full respiration subsides into the calm regularity of health; the temperature, both in the trunk and in the extremities, returns to the normal standard, and we have what is called the remission of fever.

If remedies have been applied which affect the permanent alteration, and destruction, and removal of the malarial poison, there is no return of the chill, succeeded by fever.

If, on the other hand, the poison has not thus been removed, the same round of phenomena is repeated, the blood is again altered, the capil-

lary circulation is again retarded, and the whole round of phenomena is repeated.

If these views be correct, it is evident that malarial fever is paroxysmal, not because the action of the cerebro-spinal or of the sympathetic system is paroxysmal, but because the relations of the malarial poison to the constituents of the blood and organs and apparatuses are such, and the relations to the chemical changes necessary to the development of the physical, muscular, and nervous forces are such, that a definite series of actions and of chemical changes are established, which result in the removal of the offending products; but not always of the primary, disturbing element, the poison, which will again excite another round of the same class of actions—a paroxysm.

The theory here advocated is based upon thousands of observations upon the pulse, respiration, temperature, physical and chemical changes of the solids and fluids during all the stages of fever and after death, and is consistent with every fact and observation recorded in this essay. It is important, because it does not call in the aid of occult qualities of the nervous system, or the assistance of the unknown vis-medicatrix naturæ; because it expresses an analysis of the phenomena, at the same time that it indicates the true principles of the treatment of malarial fever; and it is especially important, because it points out the relative position and importance of the phenomena, and the true direction of scientific investigation.

Without multiplying at this time facts, we would simply adduce the phenomena of congestive fever, as conclusive demonstration of the truth of this theory, or, rather, expression of the relations of the phenomena of fever. In congestive fever, where the nervous system is overwhelmed, and does not respond to the action of the altered compounds, no elevation of temperature is produced, the chemical changes are perverted and retarded, and the temperature sinks both in the trunk and in the extremities, the altered products remain, and death is inevitably the result, unless those remedies can be applied which will arouse the sympathetic and cerebro-spinal systems; arouse the action of the heart; arouse the chemical changes in the capillaries, and lead to a vigorous development of the physical, chemical, muscular, and nervous forces, and result in the elimination of the altered products and the poison.

The following pathological observations will substantiate the

assertions, with reference to the alterations of the nervous structures during malarial fever:—

Case of intermittent fever occurring in the latter stages of phthisis pulmonalis.

When the skullcap was removed, about f℥ij of subarachnoid and cerebro-spinal fluid, colored red by the blood which escaped from the vessels divided during the removal of the skullcap, flowed from the base of the brain.

Dura mater normal.

Arachnoid membrane slightly opalescent in several spots, especially in the neighborhood of the large bloodvessels; the greater part of this membrane, however, was transparent and normal in appearance.

Subarachnoid fluid moderately abundant.

Bloodvessels of pia mater filled with blood. There were no marks of inflammation either in the pia mater or in the arachnoid membrane.

The ventricles of the brain contained small quantities of serum.

The cortical and medullary substances, the cerebellum, pons Varolii, the medulla oblongata, and the spinal marrow, appeared natural to the naked eye. The structures did not appear to be softened or materially altered.

Case of remittent and typhoid fevers combined.

Several days before the fatal termination, the cerebral symptoms were well marked. The patient lay in a stupor, with mouth and eyes open, and passed his urine and feces in bed; and it was impossible to arouse him, even by the most violent shaking. The examination of the blood, on the day previous to death, showed that it had undergone profound alterations.

Dura-mater perfectly natural; arachnoid membrane opalescent (pearl colored) in most parts. There were different degrees of this opalescency, from almost perfect transparency to semi-translucency. This change was especially evident in the neighborhood of the large bloodvessels, and in those portions of the arachnoid which covered the depressions between the convolutions. Bloodvessels of pia-mater somewhat more distended with blood than usual; but not so much, however, as to account for the cerebral symptoms during life. Substance of brain firm, and not more congested with blood than normal. The appearance of the structure and condition

of the brain, and its bloodvessels and membranes, did not correspond to the condition of congestion, effusion, or softening, which the cerebral symptoms led us to expect. The brain was not examined microscopically or chemically, and there may have been minute chemical and physical changes in its delicate structures, which escaped the observation of the naked eye. This is possible, but not probable; for we can hardly suppose that profound alterations in the structure of so delicate an organ as the brain, without some changes in the color or consistence palpable to the naked eye. The cerebro-spinal phenomena during life appear to have been the result of disturbances in the circulation and constitution of the blood, and of the action of the poison or its products in the blood upon the ganglionic cells and commissures.

Case of an Irish baker, attacked during convalescence from remittent fever with influenza, and drowned by the effusion of serum into the bronchial tubes and air-cells.

Dura mater presented the usual appearance; arachnoid membrane transparent; bloodvessels of pia mater filled with blood. When the dura mater was removed, an ulcer in the substance of the brain was discovered, occupying a position near the centre of the superior surface of the left hemisphere of the cerebrum. This ulcer was three-fourths of an inch in length and half an inch in breadth, and about one-eighth of an inch in depth. The walls were thickened and much harder than the surrounding brain. The bloodvessels of the surrounding pia mater and brain were congested with blood, and there was an effusion of a small quantity of bloody serum between the arachnoid and pia mater, in the immediate neighborhood of the ulcer, but nowhere else. The appearance of the ulcer, and the congestion of the bloodvessels around, by no means accounted for the death of the patient. The ulcer appeared to be of long standing, and was in the process of healing. During the attack of malarial fever, and during convalescence, the patient was dull, lethargic, and indisposed to exert his mind or body. The existence of this ulcer will account for these phenomena, but not for the death of the patient, which was due to the rapid pouring out of the altered liquor sanguinis of the blood into the air-cells and bronchial tubes. The cerebral symptoms after this calamity were not different from those which would occur in impeded respiration and circulation, when the distribution of the oxygen and the removal of the carbonic acid were retarded. The ventricles of the brain

contained the usual amount of clear fluid, and the structures of the brain presented the usual consistence and appearance.

Case of Irish laborer, attacked with pleuro-pneumonia, during convalescence from remittent fever.

During the attack of remittent fever, which was severe, the cerebral symptoms were absent. During the attack of pleuro-pneumonia which supervened immediately upon the remittent fever, the cerebral symptoms were well marked; great excitement and frequent aberrations of the intellectual faculties.

Dura mater healthy; arachnoid membrane transparent throughout its extent over the hemispheres of the brain. At the base of the brain it was slightly opalescent. Bloodvessels of pia mater not more filled with blood than usual. The cortical and medullary substances of the cerebrum and cerebellum, the pons Varolii, the medulla oblongata, and superior portion of the spinal marrow, appeared natural in consistence and color; ventricles of the brain contained f℥iv of golden-colored serum. The superior longitudinal sinus of the dura mater contained a golden-yellow elongated clot, the diameter of which was about one-half that of the longitudinal sinus.

Case of an Irish laborer, who was attacked in the early stages of convalescence from intermittent fever, with an eruptive disease resembling the severest form of lichen agrius.

This patient had been exposed to the malarial influence in a low, damp, marshy situation. The eruption was very thick upon the face, neck and chest; in these regions, and especially upon the face, the papulæ were very numerous, prominent, of a vivid red color, and in many places closely aggregated into large clusters, of irregular form and size. Numerous vesicles and pustules, containing sero-purulent fluid, were mingled with the papulæ. From the clusters of papulæ, vesicles and pustules, an ichorous or sero-purulent fluid issued, and desiccated into yellow crusts. In some places, from the thickening of the skin, the density of the crust, and the depth of the fissures, the disease might have been mistaken for psoriasis. On the legs the eruption was much thinner, and resembled lichen tropicus (prickly heat). The vesicles and pustules were so large and numerous, that across the ward the eruption resembled smallpox. Under treatment, the discharge of sero-purulent fluid ceased, the pustules and vesicles dried up, and the symptom gra-

dually disappeared, but the patient continued weak and feeble and lethargic. Twelve days after his entrance into the hospital with the eruption, he was seized with a strong convulsion, which lasted about ten minutes, and was succeeded by stupor. Four hours after the convulsion, could not be aroused by the loudest interrogations and the most violent shaking. The left arm was drawn across the breast, and appeared paralyzed. It required considerable force to straighten it, and when released it would fly back to its former position, like a steel spring. The left leg was also paralyzed, and in like manner returned when removed from its position. The patient remained in this state forty-eight hours, and then died.

When the skullcap was removed, about f℥vj of blood flowed from the base of the brain. Dura mater normal in appearance; arachnoid membrane slightly pearl colored, opalescent in several places; bloodvessels of pia mater, especially at the base of the brain, filled with blood. Much blood and bloody serum were effused between the dura mater and arachnoid membrane. Cerebellum and pons Varolii of a blood-red color upon the exterior. The ventricles of the brain were almost entirely filled with serum. The structure of the brain appeared to be somewhat softer than usual, and the bloodvessels were filled with blood, and distinct. Bloodvessels of medulla oblongata and superior portion of spinal cord filled and distended with blood. Much bloody serum was effused around the spinal cord. No clots were found in the blood and serum effused around the brain. The liver and spleen bore the marks of the effects of malarial fever; they were, however, recovering. It is impossible to determine positively the cause of this sudden effusion of blood and serum upon the brain. Were the softening of the nervous structures and alterations of the capillaries the results of the malarial poison? or were they the results of the action of the cause, whatever it was, which produced the eruption?

Case of remittent fever, occurring in an Irish baker, of feeble constitution, during exposure and dissipation. This patient died without any treatment, except the administration of a purgative.

Dura mater and arachnoid membrane normal; bloodvessels of pia mater contained more blood than usual, but there were no marks of inflammation; f℥j of clear serous fluid escaped from the spaces between the dura mater and arachnoid membrane, and between the arachnoid membrane and pia mater.

Case of remittent fever converted into congestive fever, by excessive purgation, and neglect of stimulation and the sulphate of quinia.

Towards the close of life the intellect was sluggish, but perfectly clear when aroused. Throughout the attack there were no well-marked cerebral symptoms. *Brain examined twelve hours after death.*

Dura mater unusually thick and firm, and adherent in several places to the arachnoid membrane. The thickening of the dura mater and the adhesions were of long standing, and were not connected with this attack of malarial fever. Bloodvessels of the dura mater filled with blood; arachnoid membrane opalescent, pearl colored, and in many places adherent to the pia mater. These adhesions, like those between the dura mater and arachnoid membrane, were apparently of long standing. Between the arachnoid membrane and pia mater bloody serum was effused, thus imparting to these membranes (especially the inferior portions from the gravitation of the blood) a red appearance. Bloodvessels of pia mater were filled with blood. The bloodvessels of those portions of the pia mater which extended into the ventricles of the brain were also engorged with blood. The ventricles of the brain contained a small quantity of clear serum. Structure of cerebrum appeared to be somewhat softer than normal. This softening may have been the result of post-mortem decomposition. Bloodvessels in the substance of the brain distinct and more engorged with blood than usual. Structure of cerebellum, medulla oblongata, and superior portion of spinal cord presented the usual appearance and tenacity. The bloodvessels of the spinal cord appeared to be more congested with blood than usual.

Case of congestive fever, aggravated and shortened by bleeding and purgatives, and allowed to run its course unchecked, by the neglect of stimulants and sulphate of quinia.

Before the abstraction of blood the cerebral symptoms were urgent. The patient appeared to suffer intense agony in his head; both hands were clasped around his head; he tossed violently about his bed; every breath was accompanied with a deep groan, and an exclamation about the pain in his head; and he was unable to give a coherent answer. Cut-cups to the temples and back of the neck, general bloodletting, and sinapisms, relieved the cerebral symptoms. Stimulants and sulphate of quinia were not administered, and the cerebral symptoms returned with much less violence,

and at the end of fifty hours the patient died. When the skullcap was removed, four hours after death, f℥ij of blood flowed from the base of the brain, and appeared to have come, in great measure, from a rupture in one of the sinuses of the dura mater.

Arachnoid membrane opalescent, pearl colored. A small quantity of yellow serum was effused between the arachnoid membrane and pia mater. Bloodvessels of pia mater engorged with blood. Substance of brain appeared to be softer than usual. Upon the cut surface were seen the cut extremities of numerous bloodvessels filled with blood. The lateral ventricles of the brain were nearly filled with golden serum. Bloodvessels of that portion of the pia mater which enters the ventricles engorged with blood. Bloodvessels at the base of the brain and superior portion of the medulla oblongata greatly distended with blood. The bloodvessels at the base and dependent portions of the brain were more distended with blood than those of the superior portions of the brain. There were no marks of inflammation anywhere, and the congestion of the blood in the bloodvessels appeared to be due to its stagnation from disturbances of the general and capillary circulations, produced by the altered blood and the formation of heart clots and fibrinous concretions in the pulmonary arteries and veins.

Case of congestive fever; death resulting, in great measure, from the formation of fibrinous concretions in the heart and bloodvessels.

The cerebral symptoms appeared suddenly, and were of the most marked and decided character. The patient was taken suddenly with coma, and lay with his mouth and eyes open, perfectly insensible, and emitting at every breath a sharp, quick groan, like the barking of a dog. When the skullcap was removed, *three hours after death*, f℥iij of bloody serum flowed from the base of the brain. The admixture of blood with the cerebro-spinal fluid appeared to have been due entirely to the wounding of bloodvessels during the removal of the skullcap. The arachnoid membrane was but slightly opalescent; in most places it was perfectly transparent. The fluid effused between the arachnoid membrane and pia mater, and into the ventricles of the brain, presented the golden color of the serum of the blood. Bloodvessels of pia mater filled with blood. Bloodvessels at the base of the brain, and upon the medulla oblongata and spinal cord, more engorged with blood than those upon the superior portions of the brain. This was, without doubt, due solely to the

effect of gravity. The substance of the brain possessed the usual consistency, and appeared to the naked eye to be normal in structure.

Case of congestive fever.

Stout seaman, sick only four days. On the second day became comatose, and continued insensible, passing his urine and feces in bed until death. The treatment was defective in energy. Stimulants and sulphate of quinia were not used with sufficient freedom and frequency. *Brain examined twenty hours after death.*

Dura mater and arachnoid membrane presented a healthy appearance. The subarachnoid fluid was of a reddish color. The ventricles of the brain were almost completely filled with a reddish fluid. Bloodvessels of pia mater congested with blood. Bloodvessels of the superior portions of the brain less congested with blood than those of the inferior portions. The substance of the brain presented nothing abnormal to the naked eye, or to the touch.

Case of remittent fever, neglected for ten days, terminating in congestive fever.

Four days before death cerebral symptoms well marked; great torpor of the intellect when stimulants were withheld, and when freely administered unusual excitement, attended with aberration and incoherency. *Brain examined twelve hours after death.*

Dura mater normal; arachnoid membrane opalescent, pearl colored in many spots; subarachnoid fluid in normal quantity; bloodvessels of pia mater filled with blood; substance of brain firm, and altered neither in consistency nor in appearance. Bloodvessels of the substance of the brain not more distinct than normal; ventricles of brain, and the space around the medulla oblongata and spinal cord, filled with light yellow fluid. When the medulla oblongata, and superior portion of the spinal cord were removed, the serum flowed in (the shoulders being slightly depressed), and filled the vertebral canal.

Case of congestive fever; fibrinous concretion in the heart and bloodvessels, cerebral symptoms severe, coma, and complete insensibility. Brain examined twelve hours after death.

The longitudinal sinus of the dura mater contained an elongated, flattened, ribbon-like, fibrinous clot, which was free from colored blood-corpuscles, and of a light yellow color. This was, without

doubt, formed before death. Arachnoid membrane opalescent, pearl colored in many places. Bloodvessels of pia mater filled with blood. Substance of brain appeared to be normal in color and texture, as far as an examination with the naked eye extended; it was, perhaps, a little softer than usual; but this may have been due to post-mortem changes, and at any rate would not account for the symptoms during life. Bloodvessels of medulla oblongata and superior portion of spinal cord not congested with blood.

Case of congestive fever. Death occurred forty-three hours after the commencement of the attack, which commenced suddenly, with vomiting, cold extremities, complete prostration, and delirium.

When the skullcap was removed, *twenty-four hours after death*, f℥iij blood flowed from the base of the brain, which contained no coagula, and appeared to have been effused before death. Arachnoid membrane opalescent in a few spots. Bloodvessels of pia mater filled with blood. The sub-arachnoid fluid was of a bloody red color. Bloodvessels at the base of the brain, and surrounding the medulla oblongata and superior portion of the spinal cord, were filled with blood. The substance of the brain was normal in consistence and appearance.

Chest.

The *lungs*, in uncomplicated malarial fever, presented no abnormal appearance, except the accumulation of the blood in the most dependent parts, which resembled in all respects and were due to the same causes as the accumulation of the blood in the vessels of the most dependent parts of all the organs and tissues.

The *heart* presented no uniform pathological alterations which could be referred to malarial fever. In the hearts of drunkards, fatty degeneration was frequently observed; but this was an effect of the alcohol, and not of the malarial poison. In some cases the heart was paler and softer than usual; these did not appear to be uniform alterations.

Alimentary Canal.

During the severe forms of malarial fever, the secretions of the *mouth* were, as an almost universal rule, suppressed; and the tongue, when not coated with fur, presented a bright red, dry, rough surface, with enlarged papillæ. The bright red color of the tongue was due to the stagnation of the blood and the accumulation

of the blood-corpuscles in the capillaries. In numerous instances I have observed the dry, harsh, hard tongue become soft and moist under the action of stimulants and sulphate of quinia. This suppression of secretion and congestion of the bloodvessels of the tongue and mucous membrane of the mouth, was the result of derangements in the capillary circulation, induced by altered blood, by the disturbed circulation, and by aberrated nervous force supplied by the sympathetic system, and not of inflammation or irritation. *We consider the glowing, red, dry tongue of remittent and congestive fever as a valuable index of the condition of the capillary circulation in other parts of the body. It does not by any means indicate an inflamed or even irritated state of the stomach.* In several cases, which presented throughout their course dry, red tongues, as hard and as rough as boards, attended with great tenderness of the epigastrium, the stomach presented after death a normal appearance, without any marks of inflammation, or even of irritation.

STOMACH AND INTESTINAL CANAL.

The pathological alterations of the *stomach*, observed after death, did not correspond to the severity of the symptoms, the vomiting, and pain upon pressure, during the progress of the fever. The injection of the bloodvessels, and the mottled, purplish, brownish-red color after death, appeared to be indicative, not of inflammation, but rather of stagnation and accumulation of the blood in the capillaries, consequent upon the disturbance of the relations of the blood to the capillaries. The distressing vomiting, so often a troublesome symptom in malarial fever, appeared to depend upon the contact of the altered bile (the stomach was frequently found discolored with bile), and the irritation of the nervous centres which supply the stomach with nervous force by the altered blood and by the malarial poison.

In cases where there has been chronic inflammation of the stomach before the appearance of the fever, and in cases of long standing, where the solids and fluids were permanently altered, decided alterations of structure were found in the stomach. It may be asserted, however, that there is no constant and characteristic lesion of the stomach in malarial fever, which would distinguish it from other fevers.

These remarks apply also to the small intestines. The mucous membrane frequently presented a purplish, irregularly injected, mottled appearance, especially after the administration of purga-

tives; and it was frequently observed that the injection of the bloodvessels was greatest in the dependent portions of the intestines. In several cases, Brunner's glands in the duodenum were enlarged and distinct. The solitary glands of the small intestines appeared in many cases enlarged and distinct. Peyer's glands, in all the cases except one which was characterized by true typhoid symptoms, were uniformly free from any well-marked morbid alteration. In some cases they were distinct and well defined in their outline, and presented a honey-comb surface dotted with dark points; but they were always free from marks of inflammation, and even of irritation, and in their pale white color contrasted strongly with the surrounding mucous membranes, discolored with bile, and often irregularly injected with blood.

These statements will now be illustrated by the following post-mortem examinations:—

Case of intermittent fever occurring in the latter stages of phthisis pulmonalis. Autopsy twelve hours after death.

Stomach small, contracted; small intestines and colon inflated with air. Mucous membrane of stomach of a purplish-red color in spots, presenting a mottled appearance. Bloodvessels upon the exterior filled with blood. The small intestines contained fecal matters colored by bile. Mucous membrane of the small intestines of a dark-purplish and reddish-yellow hue. Bloodvessels upon the exterior and through the structures of the intestines were filled with dark blood. Glands of Peyer normal, not enlarged nor congested. Brunner's glands did not attract attention.

Case of remittent and typhoid fevers combined. Autopsy four hours after death.

Internal surface of the stomach, colored yellow with bile. As far as the unaided eye could ascertain, the mucous membrane was continuous and unaltered in structure. The bloodvessels of the mucous membrane were filled with blood, and several spots were more engorged with blood than the rest of the surface, presenting an ecchymosed appearance. The mere stagnation of the blood in the vessels and capillaries of the mucous membrane is not significant of alterations in the structures, or of inflammation, or even of irritation. To the naked eye there were no pathological alterations in the structures of the stomach.

The color of the intestines, externally and internally, was darker

than usual; the small intestines contained fecal matters, epithelial cells, mucus-corpuscles, and mucus colored yellow with bile. Blood-vessels of the mucous membrane of the small and large intestines injected with blood. The mucous membrane was most injected with blood, and presented a purplish color, in the last eight feet of the inferior portion of the ileum. This engorgement of the blood-vessels was greatest in the immediate region of the ileo-cæcal valve. The solitary glands were numerous, enlarged, elevated and distinct, and of a brown color. When the intestines were held up to the light, bloodvessels engorged with blood, were seen passing to each gland. The bloodvessels supplying the solitary and Peyer's glands were more engorged with blood than those supplying the mucous membrane generally. These solitary glands were most numerous in the neighborhood of the ileo-cæcal valve, and were found scattered over the superior portion of the colon; and over the cæcum, and over eight feet of the inferior portion of the ileum.

Peyer's glands were enlarged and elevated. These glands were of various sizes, from one-quarter of an inch to half an inch in breadth. They occurred at intervals of from one to two inches from each other, and extended from the ileo-cæcal valve, along the mucous membrane of the ileum, for about nine feet. The blood-vessels around these glands were engorged with blood. This part of the mucous membrane of the ileum, studded with the solitary and Peyer's glands, was far more injected with blood than the stomach, jejunum, or superior portion of the ileum. Although these glands were enlarged, elevated, and injected with blood, still they could not, by any means be compared to the condition of these glands, in an advanced stage of typhoid fever.

That this case was one of typhoid fever was demonstrated by the great susceptibility of the intestinal canal to the action of small doses of purgatives, the continued elevation of the temperature, and rapid action of the pulse without any remission, the appearance of albumen in the urine, and the low muttering delirium; that it was also a case of remittent fever was demonstrated by the slate or bronzed liver, the alteration in the blood, and the disorganized enlarged spleen.

Case of an Irish baker, attacked during convalescence from remittent fever, with influenza, and drowned by the effusion of serum into the bronchial tubes and air-cells. Autopsy eight hours after death.

Stomach, pale and perfectly healthy in appearance. Intestinal canal, from the stomach to the anus, pale and healthy in appearance.

Case of Irish laborer, attacked with pleuro-pneumonia during convalescence from remittent fever. Autopsy nine hours after death.

Stomach enormously distended with gas. Mucous membrane pale and healthy in appearance. Small intestines and colon healthy in appearance to the naked eye.

Case of an Irish laborer who was attacked in the early stages of convalescence from intermittent fever, with an eruptive disease resembling the severest form of lichen agrius, and who died suddenly from effusion of blood upon the base of the brain. Autopsy five hours after death.

Bloodvessels upon the exterior of the stomach filled with black blood. Internal mucous membrane generally of a reddish and pinkish color, and in many spots where the congestion was greater, the color was much deeper. Brunner's glands in the duodenum, and Lieberkühn's follicles, in the pyloric extremity of the stomach, and in the pylorus and duodenum, appeared to be enlarged, and gave to the mucous membrane a mammillated appearance.

Mucous membrane of the small intestines of a reddish color, with bloodvessels filled with blood, especially at the superior portion. The glands of Peyer, in the inferior portion of the ileum, especially in the region of the ileo-cæcal valve, were enlarged. Solitary glands in the superior portion of the colon also enlarged. Mucous membrane of the stomach and intestines was colored yellow by the bile. The small intestines contained much offensive gas, tenacious mucus, and fecal matters colored yellow by the bile. The colon was distended with offensive gas.

Case of a house painter, who during convalescence from a severe attack of malarial fever was seized with convulsions, and died comatose. Autopsy five hours after death.

Stomach and small and large intestines presented a healthy appearance.

Case of German butcher, who, after suffering with chill and fever for two months without any medical attendance, was seized with congestive fever. Autopsy four hours after death.

He was relieved from congestive fever, but the alterations of the organs and tissues and blood had been so profound, that notwithstanding the use of alteratives, sulphate of quinia, stimulants, and nutritious diet, he died twenty-three days after the attack of congestive fever. Previous to death the digestion was imperfect and the bowels loose.

The stomach and small and large intestines were greatly contracted. Bloodvessels of mesentery, omentum, and exterior surface of stomach, and small and large intestines, engorged with black blood. The mucous membrane of the stomach presented an appearance resembling that of chronic inflammation. The exterior of the large and small intestines was of a purplish color. The mucous membrane of the small intestines did not appear to be altered in structure. Glands of Peyer, enlarged and distinct; some of them were several inches in length. The glands of Peyer, however, did not present the appearance of active inflammation, as in typhoid fever. They were even paler than usual. The solitary glands did not attract attention. The lymphatics of the mesentery were much enlarged.

It is worthy of note that in this case, which assumed a low typhoid type, the glands of Peyer were not inflamed.

Case of remittent fever, occurring in an Irish laborer of feeble constitution, during exposure and dissipation. This patient died without any treatment except the administration of a gentle purgative. Autopsy four hours after death.

The mucous membrane of the stomach presented the usual healthy appearance. The mucous membrane of the small intestines appeared to be healthy. Glands of Peyer large and distinct, but pale, and without any marks of congestion or inflammation. Several of these glands were three inches in length. The solitary glands, especially in the region of the ileo-cæcal valve, were enlarged and prominent. They were about the size of millet-seed, and of a reddish-brown color.

Case of remittent fever, converted into congestive fever by excessive purgation and neglect of stimulation and the sulphate of quinia. Autopsy twelve hours after death.

The stomach contained no fluid or gas; bloodvessels upon the exterior filled with blood; mucous membrane of stomach of a dark purplish color. The color of the mucous membrane was not uniform; it was much deeper in some spots than in others, thus presenting a mottled appearance. The compound muciparous follicles (Brunner's glands) of the stomach and duodenum were prominent and enlarged.

Bloodvessels of the superior and inferior portions of the intestinal canal appeared to be more engorged with blood than those of

the middle portions. The mucous membrane of the small intestines was covered by a layer of mucus and fecal matter, colored yellow by the bile.

The solitary glands in the inferior portion of the ileum, and especially in the region of the ileo-cæcal valve, were enlarged and distinct. The glands of Peyer were distinct, but not enlarged or inflamed.

Case of congestive fever, aggravated and shortened by bleeding and purgatives, and allowed to run its course unchecked, by the neglect of stimulants and sulphate of quinia. Autopsy four hours after death.

Mucous membrane of stomach corrugated and of a purplish color, varying in intensity in different spots. The stomach contained eight fluidounces of a dark greenish-black fluid, which resembled, upon a general view, the black vomit of yellow fever. Under the microscope this fluid was found to contain numerous mucus-corpuscles, epithelial cells of the mucous membrane, and gastric glands, peptic cells, and dark granules. These various bodies were of a greenish and yellow color under the microscope. The action of nitric acid demonstrated that the color was due to the presence of bile. The color of a mass of this fluid from the stomach, like that of the bile from the gall-bladder, was of a dark blackish-green color, whilst the thin layers, like those of the bile, were of a yellow color. I was unable to distinguish any colored corpuscles, notwithstanding the close resemblance to black vomit. The granules did not resemble altered blood-corpuscles.

The color of the mucous membrane of the small intestines was darker than usual, and the surface was covered with mucus-corpuscles and epithelium, colored yellow by bile.

Bloodvessels of the ileum, especially in the region of the ileo-cæcal valve, engorged with blood. Neither the glands of Peyer nor the solitary glands were enlarged. Bloodvessels of colon filled with blood. Exterior surface of rectum diversified by numerous ecchymosed spots of a bright arterial hue.

Case of congestive fever. Death resulting in great measure from the formation of fibrinous coagula in the heart and bloodvessels. Great tenderness upon pressure of epigastrium. Autopsy three hours after death.

Stomach distended with gas. Mucous membrane discolored by

yellow bile, and diversified with punctated spots of a brilliant red color.

Small intestines contained bile and feces, which were extraordinarily offensive. The calomel and oil administered previous to death had commenced to operate. When the feces and epithelial cells, colored yellow by bile, were scraped off, the mucous membrane presented the normal appearance. The glands of Peyer were remarkably large and distinct; several of them were three inches in length; their surfaces were pale, and exhibited no marks of inflammation.

Case of congestive fever. Stout seaman, sick only four days. On the second day became comatose, and continued insensible, passing his urine and feces in bed until death. Autopsy twenty hours after death.

The mucous membrane of the alimentary canal, from the œsophagus to the anus, presented the normal color, and showed no signs whatever of congestion or inflammation.

Case of remittent fever, neglected for ten days, terminating in congestive fever. Tongue red, dry, and hard. Autopsy twelve hours after death.

Bloodvessels upon the exterior of the stomach filled with blood. The mucous membrane bore no marks of inflammation, and was not more congested with blood than usual.

The exterior and mucous membrane of the jejunum presented the usual appearance. There was no unusual appearance, either of congestion, irritation, or inflammation. The mucous membrane of the ileum, especially at the lower portion, was more congested with blood, and of a darker color than usual. The intestinal canal, through its entire length, was empty. The mucous membrane presented a yellow appearance, probably due to the presence of bile.

The solitary glands of the ileum, especially in the neighborhood of the ileo-cæcal valve, were numerous, enlarged, elevated, distinct, and of a brown color. When the intestines were held up to the light, the bloodvessels filled with blood could be distinctly seen sending off branches to each gland. The glands of Peyer were large, distinct, and elevated. Several of these glands in the lower portion of the ileum were three inches in length. These glands, however, were not inflamed, as in typhoid fever, and presented the usual pale appearance.

Case of congestive fever. Fibrinous concretions in the heart and bloodvessels; cerebral symptoms severe; coma and complete insensibility; tongue red, dry, rough, and hard. Autopsy twelve hours after death.

Exterior surface of stomach and intestines pale. Bloodvessels of omentum and mesentery were filled with black blood. The stomach contained a yellow, mucus-like fluid. The mucous membrane of the stomach was dyed yellow by the bile. With the exception of this discoloration, the mucous mémbrane of the stomach appeared to be normal. There were no marks of inflammation. The small intestines contained large quantities of yellow mucoid matter, mixed with soft fecal matters. When carefully and completely washed under a gentle stream of water, the free edges of the valvulæ conniventes presented a bright red and bistre color, which diminished in intensity towards the attached portion. The whole surface of the mucous membrane of the small and large intestines was of a darker color, and indicated much more congestion than usual. I do not consider the congestion of the bloodvessels of the mucous membrane as a pathological alteration, due either to the primary or secondary effects of the malarial poison, because at the time of his death the patient was under the action of a cathartic. Cathartics, as far as my experiments upon animals have extended, produce engorgement of the vessels of the mucous membrane of the intestines. Glands of Peyer and solitary glands not enlarged or inflamed.

Case of congestive fever. Death occurring forty-three hours after the commencement of the disease, which was ushered in suddenly with vomiting, cold extremities, complete prostration, and delirium. Autopsy twenty-four hours after death.

The mucous membrane of the stomach presented two well-defined portions; the mucous membrane of the lesser curvature of the stomach was pale and normal in appearance; the mucous membrane of the greater curvature and pyloric extremity, and of the pylorus, was of a purplish color, and ecchymosed in crimson spots. The bloodvessels of the greater curvature and of the pylorus were congested with blood. Mucous membrane of the superior portion of the jejunum congested with blood; valvulæ conniventes, especially at the edges, ecchymosed in spots, of a purple and scarlet color. Mucous membrane of the lower portion of the ileum greatly congested with blood. Peyer's glands somewhat enlarged, more distinct and elevated than usual, but pale and not congested and

inflamed as in typhoid fever. Solitary glands enlarged and distinct. Mucous membrane of colon greatly congested with blood.

Liver.

The size of this organ, the complexity and delicacy of its structures, and the extent and variety and importance of its offices, all demonstrate the value and necessity of careful microscopical and chemical examinations of its structures, blood and products, in pathological conditions. The necessity of these careful examinations is placed in a stronger and clearer light every time that the bounds of pathological and physiological science are enlarged.

Modern research has confirmed the ancient idea that the liver is the fabricator of the blood. M. Cl. Bernard[1] has demonstrated that the liver is a great starch and sugar manufactory, that it possesses the power of converting cane sugar into hepatic sugar, and of changing the albuminose received from the alimentary canal through the portal circulation, into the albumen of the blood.

Weber[2] has shown that there is an extensive generation of colored blood-corpuscles in the liver of the embryo, and in the liver of the frog in the spring of the year, when the sexual organs are highly developed, and when the lymphatic system is in a highly active state.

Kölliker[3] and Bernard[4] have confirmed these observations, and it is now known that there are both a destruction and a regeneration and formation of the colored and colorless corpuscles in the liver.

Thackrah, Simon, Lehman and Bernard have shown that the fibrin is altered both in quantity and quality, during its passage through the liver.

According to Simon and Lehmann, the fats are diminished in the blood passing through the liver.

The extractive matters, according to several observers, are increased in hepatic blood, whilst the albumen, salts, and iron are diminished.

These facts, and many others as well established, indicate that the complete examination of the liver in physiological and pathological conditions, requires a careful analysis and comparison of

[1] "Lectures on the Function of the Liver," L'Union Médicale, 1850.

[2] Henlé and Pfeufer's Zeitschrift, 1846.

[3] Kölliker über die Blutkörperchen der Menschlichen Embryo und die Entwickelung der Blutkörperchen der Saggethieren.

[4] Bernard and Robin on the Blood; translated by W. T. Atlee, M. D., Philada. 1854, p. 106.

the blood in the portal system before its entrance into the liver, and of that in hepatic veins, which has traversed the liver—requires a careful analysis of the venous blood in other parts of the system, and a comparison of the venous, portal, and hepatic blood—requires a careful chemical analysis, quantitative and qualitative, of the starch and sugar and bile and other matters separated or elaborated from the blood by the liver—requires a complete chemical analysis of the contents of the capillaries, and of the biliary tubes and cells, and of the walls of these capillaries, tubes and cells—requires a complete microscopical examination of all the structures of the liver. Not even one single division of these separate subjects of inquiry can, in the present state of physiological and pathological science, be executed with absolute accuracy, and the majority are so complex and difficult of investigation, that even the attempt has never been made.

Besides the difficulties necessarily attending the procuring of the blood from the portal and hepatic veins; the value of the analyses must be in a great measure vitiated, and the conclusions based upon them rendered doubtful in the extreme, by the changes in the circulation and in the chemical constitution of the blood during the last moments, independent entirely of the original changes resulting from the action of the poison.

The difficulty of correct microscopical examination of the liver, is strikingly shown by the differences of opinion amongst the most distinguished anatomists, with reference to the connection of the liver-cells with the hepatic ducts.

Kiernan,[1] Schroder Vander Kolk,[2] Krukenberg,[3] Weber,[4] Retzius,[5] Theile,[6] Backer,[7] Leidy,[8] and Beale,[9] have advocated the

[1] "The Anatomy and Physiology of the Liver," by Francis Kiernan, Philosophical Transactions, 1833.

[2] In Backer's Essay, "De Structura Subtilori Hepatis Sani et Morbosi."

[3] Gerlach's Gewebelhre, ii. Auflage, p. 329. Untersuchungen ueber den feineren Bau der Menschichen Leber, in Müll. Archiv., st. 318.

[4] Annot. Anat. et Physiolog., prol. vi., vii., viii., Lips. Zusätze zu seinen Untersuchungen über den Bau der Leber in Berichte der K. Sachs. Ger. d. Wissench zu Leipzig, st. 151. Programmatar Collecta, Fasc. ii. Lips.

[5] Uber den Bau der Leber, Müll. Archiv. ii. p. 141.

[6] Art. Leber, in R. Wagner's Handw. der Phys. ii. st. 308.

[7] De Structura Subtiliori Hepatis Sani et Morbosi, Dis Inaug. Trajecti ad Rhenum.

[8] "Researches into the Comparative Structure of the Liver," by Joseph Leidy, American Journal of the Medical Sciences, January, 1848, p. 18.

[9] On Some Points in the Anatomy of the Liver of Man and Vertebrate Animals, by Lionel S. Beale, M. D. London, 1856.

existence of a tubular basement membrane, continuous with the ducts, within which lie the liver-cells.

Kolliker[1] describes the hepatic cells as so arranged in the lobules as to form a network, by the simple apposition of the flat surfaces, without the assistance of any foreign connecting, intermediate, or investing coat. Not a trace of biliary ducts is to be observed in this network, and it is impossible to make out any connection between the biliary ducts and hepatic-cell network, which is undoubtedly the secreting portion of the liver.

Dr. Handfield Jones[2] asserts that the ducts terminate in blind extremities on reaching the lobule, instead of forming a plexus within it, and that the chief agents in the secretion of the bile are the cells lining these ducts, and not the cells lining the lobular substance.

Dr. H. D. Schmidt,[3] of Philadelphia, one of the latest and most accurate observers on the minute anatomy of the liver, states as the results of his observations upon fresh and injected livers, that "two capillary networks, each independent of the other, exist in the lobule of the liver; the one, commencing at the periphery of the lobule, from the smallest branches of the portal vein and hepatic artery, and ending in the centre in those of the hepatic vein, is destined for the circulation of the blood brought there by the portal vein and hepatic artery; the other, commencing independently in the centre of the lobule, near the intralobular vein (branch of the hepatic vein), and ending in the smallest branches of the hepatic duct, is most probably destined to carry off the secretion of the cells. The cells lie within the meshes of these two networks; but seem to be especially held in their position by their adhesion to the network destined to secretion."

These facts show the necessity for careful and laborious research, and the importance of having a large number of careful, conscien-

[1] Manual of Human Microscopical Anatomy, by A. Kölliker. Translated by G. Busk and T. Huxley. Philadelphia, 1854, p. 532 *et seq.*

[2] C. Handfield Jones, "On the Secretory Apparatus of the Liver;" Philosophical Transactions, 1846, p. 473. "On the Structure and Development of the Liver;" Phil. Trans., 1849, I. p. 109. "Further Inquiries on the Structure, Development, and Functions of the Liver;" Phil. Trans., 1853, part i. pp. 1–29.

[3] American Journal of the Medical Sciences, Jan., 1859, vol. xxxvii., N. S., p. 22. In this article Dr. Schmidt describes valuable apparatus for microscopical investigation, invented and constructed by himself. The use of such delicate and accurate apparatus will, without doubt, greatly facilitate and add much accuracy to microscopical examinations of the liver.

tious investigators engaged in this field. The accuracy and value of pathological investigation depend upon the state of anatomy and physiology. If anatomists and physiologists are not agreed with reference to the minute anatomy of the liver, and the mode of formation and offices of its secretions, how can the pathologist arrive at accurate and definite conclusions when he has to investigate not only the complex anatomical structures and secretions, but also examine the morbid, physical, and chemical alterations, and if possible discover the character and mode of action of the morbific agent or agents?

Notwithstanding that much time and labor were expended in microscopical and chemical examinations of the liver in malarial fever, yellow fever, and in other diseases; and notwithstanding that several facts, which appear to possess some pathological value, were discovered; still, the knowledge thus far acquired extends only to the most general and superficial phenomena, and the whole subject is open for investigation, and presents to investigators an inviting and almost entirely new and untrodden field. The imperfect results of my labors are now presented with the hope that others of far more learning and ability may be excited to enter the same field, and not only prove the truth or falsity of the observations recorded, but also remove the obscurity and absolute ignorance which now exist with reference to the cause and character of the pathological changes of all the organs, and establish such a body of scientific facts as shall lead to the careful determination of the pathological alterations and relations of all diseases.

Weight of the Liver in Malarial Fever.

	Avoirdupois pounds.	Avoirdupois ounces.	Troy grains.
Weight of healthy liver; mean of 82 observations on males	3 to 4	48–58	13000 to 25375
Ditto; mean of 36 observations on females	3 to 4	40–50	17500 to 21875
Weight of liver in intermittent fever .	3 lbs. 4½ ozs.	52½	22968
" remittent and typhoid fevers . . .	3 lbs. 11½ ozs.	59½	25642
" lichen agrius during convalescence from remittent fever . . .	5 " 3 "	83	36312
" remittent fever . .	4 " 3 "	67	29312
" congestive fever . .	5 " 0 "	80	35000
" congestive fever . .	5 " 3 "	83	36312
" congestive fever . .	4 " 3¼ "	67¼	29416

According to the researches of Dr. John Reid, the liver weighed in 43 cases out of 82 between 48 and 58 ounces in the adult male; and in 17 cases out of 36 its weight in the adult female ranged between 40 and 50 ounces.

It may, then, in general terms be stated that the weight of the liver in health varies from three to four pounds, according to the quantity of blood which it may contain at the time it is examined.

The comparison of these results with the weight of the liver in the different forms of malarial fever, shows that the weight of the liver is increased in malarial fever.

We would naturally expect this increase of weight from the stagnation and accumulation of blood in the capillaries and blood-vessels of the liver in malarial fever. In all such examinations it should ever be remembered that the weight of the liver varies considerably in health, according to the amount of blood which it contains.

Color of the Liver in Malarial Fever.

My observations upon the color of the liver, agree in the main with those of Dr. Thomas Stewardson,[1] of Philadelphia.

This distinguished pathologist first pointed out the fact that the color of the liver in malarial fever is changed from the normal reddish-brown to a slaty or bronze, or mixture of bronze and olive. The knowledge of this peculiar change of the color of the liver during malarial fever is exceedingly valuable as a means of distinguishing malarial fever from yellow, typhoid, typhus, and all other fevers.

The observations of Dr. Thomas Stewardson, have been confirmed by those of Dr. Wm. T. Howard,[2] in the Baltimore Almshouse, of Dr. Swett,[3] in the New York Hospital, of Drs. Anderson[4] and Frick, in the Baltimore Almshouse and Infirmary, and of Dr. Richard Arnold,[5] in the Savannah Marine Hospital and Poor House.

[1] Stewardson, "On Remittent Fever," American Journal Med. Sciences, April, 1841, New Series, vol. i. p. 289. Elliotson's and Stewardson's Practice of Medicine, p. 338.

[2] Communicated by Dr. Stewardson, Am. Journ. Med. Sciences, 1845.

[3] Swett "On Pathol. of Remittent Fever," Am. Journ. Med. Sciences, 1845.

[4] Published by Dr. Alfred Stillé, Am. Journ. Med. Sciences, April, 1846.

[5] "An Essay upon the Relation of Bilious and Yellow Fever, prepared at the request of, and read before the Medical Society of Georgia, April, 1856," by Richard D. Arnold, M. D. Southern Medical and Surgical Journal, vol. xii. p. 515.

In all the different forms of malarial fever, intermittent, remittent, and congestive, which had continued longer than five days, and in which there had been no previous structural alterations of the liver, as cirrhosis or fatty degeneration, I found the exterior to be of a slate color, and the interior of a bronze color. In a case of remittent and typhoid fever, the liver presented the true malarial slate color upon the exterior, and the bronze color in the interior.

In cases of death from other causes, during convalescence from malarial fever, the color of the liver, both upon the exterior and within was not so deep, and presented various shades, from the slate, to dark Spanish brown. The change in the color appears to be very persistent. I have, in several cases, observed that the liver retained shades of light slate and light bronze, several weeks after the relief of the attack of malarial fever.

The liver of a stout American seaman, who had died from a severe attack of congestive fever, of only three and a half days' duration, presented upon the exterior, a color only a shade darker than usual, with the exception of two slate-colored spots. The largest of these slate-colored spots, was four inches in diameter, and was situated upon the anterior surface of the right lobe, whilst the smallest was situated upon the posterior surface, of the left lobe. When an incision was made into the structures of the liver, through these spots, the substance presented a bronze color for the depth of a quarter of an inch. In all other parts of the liver, the cut surface presented a color only a shade deeper than normal.

In a case of congestive fever of the most sudden onset and rapid progress, which was ushered in by vomiting, complete exhaustion of the muscular and nervous forces, and profound coma; a large portion of the surface of the liver presented the healthy Spanish-brown color, and when cut, the substance presented the usual healthy color, whilst the other portions presented a mottled appearance of Spanish-brown and dark purple, and the bloodvessels of these parts appeared to be engorged with blood. The right lobe of the liver had upon its under surface a spot about two inches in diameter, of a dark slate (malarial color). When an incision was made through this portion of the liver, it presented for the depth of about one-fourth of an inch, the true bronze color.

Numerous incisions were made into the liver in all directions, so as to expose its substance fully to view; portions were found, approaching in color the bronze hue of the malarial fever liver; the

great mass of the liver, however, resembled more nearly that of a healthy liver engorged with blood. Portions from different parts of the liver were examined under the microscope.

The liver cells, from the slate-colored and bronzed portions, did not differ in appearance under the microscope, from those of the normal colored, or from those of the mottled portions.

The colored corpuscles appeared to be more altered in form in the bronzed portions, than in the normal colored portions. The alterations, however, even in the bronzed portions, were small and by no means universal, but confined to a few, and after all, the difference may have been imaginary. The determination of comparative alterations of this kind is not so easy as at first sight appears.

Did not discover any of those dark granules in the bronze portion, which have been said to impart the peculiar color to the malarial liver. The liver cells did not appear under the microscope to have been altered in any manner.

Effects of Previous Pathological Alterations upon the Color of the Liver, in Malarial Fever.

In making examinations of the different organs after death, and in attempting to determine definitely the changes of color, we should always determine, if possible, the condition of the liver previous to the disease.

There are two affections of the liver which are attended with profound alterations of the structures, and always modify the color characteristic of malarial fever.

The liver of an Irishman, who died in the latter stages of phthisis pulmonalis, from intermittent fever, presented a purplish-red color, notwithstanding the presence of the disease long enough to have produced the decided slate and bronzed color. The structure was unusually firm; it required considerable force to tear it asunder. It cut toughly under the knife, and the lobules started out from the cut surface, as if they had been bound down. The fibrous capsule surrounding the exterior of the liver, forming a sheath for the larger vessels lying in the portal canals, was thickened. The individual lobules of the liver were surrounded with fibrous tissue. Here then we have the explanation of the variation of the color of the liver from that characteristic of malarial fever.

The lobules of the liver have been described by Malpighi,[1]

[1] Malpighi, De Viscerum, Structura Bologna. London, 1699.

Kiernan,[1] Müller,[2] Leidy,[3] and others, as isolated from each other, and each invested with a layer of areolar or fibrous tissue. In the pig, in which these lobules were first noticed, and in the Polar bear according to Müller, and in the Octodon Cummingii, according to Hyrtl,[4] the lobules are invested by fibrous tissue, but in the liver of the human subject, and in that of vertebrate animals generally, the lobules are not separated from each other by a fibrous partition, and there is no areolar or fibrous tissue or prolongation of Glisson's capsule between them or in their interior.

Vogel, Henle,[5] Bowman,[6] and Beale,[7] have failed to detect any fibrous tissue in the interlobular fissures of the normal human liver.

In cirrhosis of the liver, on the other hand, there is a remarkable development of fibrous tissue in the parenchyma of the liver; and the individual secreting segments become prominent or even firm isolated lobules.

The increase of fibrous tissue in the liver of this subject was manifest to the eye, and especially when the liver was subjected to the action of a stream of water, and gently mashed between the fingers. The softer parts were washed out and the fibrous tissue remained. The character of this was determined by microscopical examination. The portions of the liver surrounded by the indurated fibrous tissue appeared to be but little altered, and could be readily scraped away.

The cirrhosed condition of the liver was not the result of malarial fever, for the microscopical examination showed that the fibrous tissue was abundant and well formed. The whole structure of the liver could not have been pervaded with fibrous tissue in a few days. It is reasonable to conclude with Dr. Budd,[8] that the re-

[1] "The Anatomy and Physiology of the Liver," by Francis Kiernan, Philosophical Transactions of the Royal Society of London, 1833, p. 714.

[2] Müller, De Glandularum Secernent Struct. Penit, Berlin, 1830. Elements of Physiology, by J. Müller, M. D., translated by Wm. Baly, M. D. London, 1840; vol. i. p. 493.

[3] "Researches into the Comparative Structure of the Liver," by Joseph Leidy, M. D. American Journal of the Medical Sciences, New Series, vol. xv., 1848, p. 18.

[4] Hyrtl, Lehrbuch der Anatomie des Menchen., 1850.

[5] Hufeland's Journal, 1838, p. 8.

[6] Article "Mucous Membrane" in Todd's Cyclopædia of Anatomy and Physiology, by W. Bowman, vol. iii. p. 497. The Physiological Anatomy and Physiology of Man, by Todd and Bowman. Philadelphia, 1857, p. 773.

[7] On Some Points in the Anatomy of the Liver of Man and Vertebrated Animals, by Lionel S. Beale, M. D. London, 1856, pp. 13, 16, 19, 72.

[8] On Diseases of the Liver, by George Budd, M. D. London, 1857, p. 143.

markable changes in cirrhosis, are mainly the consequences of adhesive inflammation in the areolar tissue about the small twigs of the portal vein, and in the areolar tissue of the portal canals, by which serous fluid and coagulable lymph are poured out. In this stage the liver may be enlarged. The serous part of the effusion is next absorbed, the lymph contracts, becomes converted into dense fibrous tissue, which divides the lobular substance of the liver into well defined masses, and gives great density and toughness to the organ. Finally, this fibrous tissue compresses the small twigs of the portal vein and the small gall-ducts, and thus impeding the escape of the bile and the flow of blood induces great atrophy of the original hepatic tissue, and causes by a deprivation of blood and the admixture of this dirty white fibrous tissue, marked changes in the color of the liver. If these views of Dr. Budd be correct, it is evident that this condition of the liver could not have resulted from an attack of malarial fever, which had commenced only twelve days before death.

This patient was an Irish laborer. This class are addicted to the free use of ardent spirits, and the true cause of this cirrhosed condition of the liver was the action of the alcohol in the portal blood, absorbed directly from the stomach and intestines upon the bloodvessels and secreting apparatus of the liver. We know that this form of disease is most frequent in large manufacturing towns, among the poorer classes, who drink large quantities of ardent spirits. All the cirrhosed livers which I have had an opportunity of examining, have been taken from the bodies of those who have been accustomed to the free use of spirits. So common and well known is this cause, that cirrhosis is familiarly termed by the English practitioners, gin-drinker's liver.

The color of the liver of this patient was very different from that generally presented in cirrhosis. Upon the inferior surface of the liver, there was a small portion of a dark slate, inclining to bronze color, resembling the color of the malarial fever liver, and forming a striking contrast with the surrounding purplish red color.

In cirrhosis, owing to the admixture of fibrous tissue and the impediment to the circulation of the blood, and the passage of the bile, and the compression of the capillaries and secreting apparatus, the normal dull-reddish brown color of the liver is altered sometimes to a bright canary yellow, sometimes to a brownish or greenish, and occasionally to a reddish color. A section of the

liver upon a general view presents the grayish and yellow color of impure beeswax.

In this case, owing to the pathological conditions of cirrhosis, the admixture of fibrous tissue, impediment of the circulation of the blood, and flow of bile, and the compression of the capillaries and secretory apparatus, the color of the liver was not so marked as in those cases of malarial fever in which the liver was normal before the introduction of the malarial poison.

Allowing due weight to the pathological changes of cirrhosis, it is evident that the change in the color of the liver was similar, in all respects, to the slate and bronze color of livers which were normal before the onset of the malarial fever.

The liver of a house painter, who died suddenly during convalescence from a severe attack of malarial fever, presented upon a general view, a light slate color, with purplish and brownish reflections. Upon nearer inspection, it presented a mottled appearance, many of the lobules presented the yellow color of cirrhosis. The cut surface presented upon a general view a light bronze and purplish yellow color. Upon close inspection, the yellow lobules were distinctly visible. Structure of the liver unusually firm, it required great force to tear it. The yellow color of many of the lobules and the large admixture of dense fibrous tissue prove that this liver was in a cirrhosed condition previous to the attack of malarial fever. The yellow color of the cirrhosis was masked very much by the characteristic effects of the malarial poison.

In the case of a German barkeeper, who died with congestive fever after seven days' sickness, the liver presented a singular mottled appearance; at a distance, it presented a light bronzed color; upon nearer inspection the lobules were found to be distinct, elevated, and of a light bronze color, whilst the spaces between the lobules inclined to a slate color. There were several spots, varying from two inches to half an inch in diameter, of a uniform slate color. The structure of the liver was unusually firm, it required considerable force to tear it asunder, it cut toughly under the knife, and the lobules started out from the cut surface as if they had been bound down. The fibrous capsule surrounding the exterior of the liver, and forming a thick sheath for the large vessels lying in the portal canals, was thickened, and the individual lobules of the liver were surrounded with fibrous tissue.

These facts, which were demonstrated, not only by the touch and naked eye, but also by the microscope, showed that this liver

was in a cirrhosed condition. Cirrhosis of the liver in this case was not caused by the action of the malarial poison, but in all probability by the habitual use of ardent spirits. This patient was a barkeeper. Men in this occupation are, as a general rule, addicted to the free use of ardent spirits. The liquors drank in this country, at the hotels and bar-rooms, contain much alcohol, which acts upon the secreting structures of the liver, and upon the bloodvessels, and excites adhesive inflammation in the areolar tissue, about the small twigs of the portal vein, and in the areolar tissue of the portal canals, by which serous fluid and coagulable lymph are thrown out.

Under the microscope, the substance of the liver contained many dark-looking masses resembling the altered blood-corpuscles of the spleen, and the black granules and flakes of black vomit. These dark masses were not sufficiently numerous to produce any marked effect upon the color of the organ. When the fibrous capsule was torn off, it presented a light slate color, and yet, when magnified and carefully examined, but few of these dark masses were seen in the meshes.

The structures of the liver and the liver-cells contained numerous oil-globules. These oil-globules existed in sufficient numbers to induce the belief that the liver was in a state not only of cirrhosis, but also of fatty degeneration.

The mottled appearance of the liver, and the want of that decided slate and bronze color characteristic of malarial fever, were due not to any peculiar effects of the malarial poison, but rather to the pathological conditions of cirrhosis and fatty degeneration. Allowing due weight to these pathological changes, it is evident that the change in the color of the liver was similar in all respects to the slate or bronze color of livers which were normal before the onset of the malarial fever.

These facts show the importance, in all pathological investigations of the physical and chemical changes of the organs after death, of determining definitely the *previous diseases and habits of the patients.* Without such examinations the most erroneous conclusions might be drawn with reference to the nature of the structural alterations of the different organs, especially of the liver, during disease.

The length of the disease should always be accurately ascertained. We know that the malarial poison is in many cases either from peculiarities of constitution, or changes in the forces induced by bad habits and previous diseases; or from the amount and con-

centration of the dose; or from the extent and importance of the offices of the organ upon which its force appears to be mainly expended; exceedingly rapid and violent in its action—death in some cases occurring in 40 hours after the appearance of the first symptoms. If the patients thus suddenly attacked have never been exposed previously to the malarial poison, we should not expect to find the characteristic alterations in the color and structures of the liver and spleen as well marked as in cases of longer standing, for all morbific changes attended with physical changes of structure and color are attended by definite chemical changes, and in most cases are absolutely dependent upon such changes, either in the blood or in the nervous systems or in the structures of the organs; and as every chemical change requires time for its production and completion, so must every pathological change have time for its production and completion. The pathological alterations of the organs would be most decidedly manifested, even after apparent sudden attacks in those who have resided for some time previous in the malarious district, for in two instances on record, the bronzed liver was found a year and more after the patient had suffered from remittent fever, and, in the interval these persons had enjoyed good health.

In localities like Savannah, Charleston, New Orleans, and Mobile, where the yellow fever has prevailed as an epidemic, it would be exceedingly important and interesting to determine the effects of previous attacks of yellow fever upon the structures and color of the liver, and the characters of the alterations presented in a subsequent attack of malarial fever. Judging by the extent and character of the alterations of the liver in yellow fever, we would say that they were as persistent as those of malarial fever, and that they would, like the alterations of cirrhosis and fatty degeneration, mask the characteristic color of the malarial liver. These facts demonstrate the extent and complexity of pathological phenomena and the number of the sources of uncertainty and error in pathological investigations.

Changes of the Color of the Blood in the Liver of Malarial Fever.

The blood of the liver in malarial fever presents a dark brownish-red and dark purplish-red color, often inclining to black, and does not change to the arterial hue when exposed to the atmosphere. If the patient dies within two days of the commencement of the disease, there may be a change in portions of the blood issuing

from the cut surface, to the arterial hue. This change takes place also in the blood of the livers, taken from patients who have died from other diseases, during convalescence from malarial fever.

Sources of the Change of Color in the Liver during Malarial Fever.

The change in the color of the liver during malarial fever is due to changes in the amount, and physical and chemical constitution of the blood in the capillaries of the liver, and to the physical and chemical changes in the bile, and the contents of the secretory apparatus.

Dr. A. Clarke[1] has announced that the hue peculiar to the malarial liver "is produced by an infinite number of colored microscopical particles of irregular shape and size, totally different from anything that enters into the constitution of the healthy liver; that these colored particles are scattered irregularly through the hepatic tissue, are seen to occupy the secreting cells of the organ, and even the nuclei of these cells; that they vary in hue from red or orange to an opaque, jet black, though much the greater number are of a semi-transparent dark-brown color; and that, in shape, the red and dark-brown particles are, some beautifully crystallized, some in globular dots and grains; while the black, often in globular grains, are also seen in friable, semi-crystalline scales, some of them almost large enough to be seen by the naked eye. The nature of this coloring matter must be sought among the chemical transformations of hematin, or coloring principle of the blood. The belief is expressed that in the remittent fever, as in many other diseased states, the hematin is readily yielded by the blood, and, passing into the liver substance, there meets with some unknown agent, which changes its chemical constitution, and converts it into the forms and colors here described."

With reference to the extent and character of his investigations, Dr. Clarke states in a note appended to the first volume of Dr. La Roche's learned work on yellow fever: "The hospital with which I am connected, though a very large one, does not receive many cases of this disease, and within the paved and sewered districts of this island it is virtually extinct. In the last seven years, I may have witnessed seven post-mortem examinations, and though I have not

[1] The History, Diagnosis and Treatment of the Fevers of the United States, by Elisha Bartlett, M. D. Edited by A. Clarke, M. D. Philada. 1856, pp. 370, 371. Yellow Fever considered in its Historical, Pathological, Etiological and Therapeutical Relations, by R. La Roche, M. D. Philadelphia, 1855, vol i. pp. 610–615.

kept notes of them, I can trust my recollection to assert that I have seen no instance in which one of the recognized hues did not exist.

"Portions of the liver in each one of these cases have been studied with the aid of the microscope, and in all, the coloring matter here called hematoidin has been found abundant, and in each case, as far as could be judged, the quantity was nicely proportioned to the intensity of the abnormal color."—p. 614.

The careful microscopical examination of the livers of fifteen cases of intermittent, remittent and congestive fever, has convinced me that whilst the red and dark-brown and black granules do occur in some cases of malarial fever, they are absent in the livers of others which do not differ in color from those in which they are present. I have seen the slate and bronze color of the liver as well marked in the liver when these dark masses were absent, as in the liver when they were most abundant. Careful microscopic examinations of the slate and bronze colored spots in the livers of those who had died suddenly with malarial fever, and of the slate and bronzed colored spots sometimes found upon the kidneys in malarial fever, demonstrated that this hue was just as decidedly marked when there was an entire absence of the peculiar dark masses.

That the peculiar color of the liver is due in a great measure to changes in the coloring matter (hæmatin) of the blood, is indicated by the fact that the blood from the capillaries of the liver will not change from the dark reddish-brown and purplish color to the arterial hue. It is probable that the altered coloring matter, resulting from the destroyed disintegrated blood-corpuscles, or from the blood-corpuscles acted on by the malarial poison without actual disintegration, escapes and permeates the surrounding tissues, and imparts the peculiar color of the liver.

The color of the liver remains the same, whether the coloring matter be retained in solution, or is precipitated, forming the dark granules.

The peculiar hue appears to be also due to the altered color of the bile. In all the cases of malarial fever which I have thus far examined, I have found the bile to be of high specific gravity, thick, concentrated, and of a greenish-black color when seen in mass, and of a gamboge yellow when spread in thin layers. The liver cells under the microscope presented a light greenish-yellow color, as if they also were infiltrated with the altered coloring matters. In some cases the liver-cells contained fewer oil-globules, and the

cell-walls looked thinner than usual; in other cases they resembled closely the healthy cells.

The peculiar color of the malarial liver can, to a certain extent, be extracted by boiling water.

In almost every case I found the filtered decoction of malarial fever livers, to be of a brownish-yellow color, whilst the decoction of yellow fever livers is of a bright golden color, whilst that of normal livers is of a light yellow. These observations, however, should be repeated upon an extensive scale, before we can decide upon the characteristic color of the decoctions of the liver in different diseases.

After the altered coloring matters of the blood and bile have infiltrated the structures of the liver, they will sometimes remain for a considerable length of time without being absorbed, and it may communicate the peculiar bronzed color to the liver, long after the restoration of its normal functions, and the disappearance of the malarial fever. I have observed, however, that the intensity of the color of the liver bears a marked relation to the time of convalescence; as convalescence advances, the color diminishes.

Characters of the Bile in Malarial Fever.

The gall-bladder, in fifteen cases of the different forms of malarial fever, was filled with bile, which had, in the majority of cases, the consistency of molasses, and presented a greenish-black, with yellowish and reddish reflections when seen in mass, and of a gamboge-yellow when spread in thin layers. In every case the mucous membrane of the small intestines were colored yellow by the bile throughout almost the entire extent, and in many cases the mucous membrane of the stomach was in like manner discolored with bile. The characters of the bile vomited during life, corresponded to that found in the gall-bladder after death.

In a case of congestive fever of only forty-three hours' duration, the specific gravity of the bile was 1042.5, and viewed in mass it presented a brownish-black color with greenish reflections, and resembled, upon a general view, a saturated tincture of iodine. It poured like molasses, being thick and ropy. Upon close inspection, the bile was found to contain numerous flakes of a green color, which, under the microscope, were found to consist of the conglomerated cells of the mucous membrane of the gall-bladder.

When spread out in thin layers, the bile presented a gamboge-yellow color.

In a case of malarial fever of eleven weeks, which had been entirely without treatment during the first eight weeks, and which ended in extensive disorganization of the blood, muscular system, and spleen, the gall-bladder was filled with bile of a brownish-yellow opaque color, when seen in mass, and of a gamboge-yellow in thin layers. The bile contained numerous, irregularly-shaped, yellow masses of various sizes, from an English pea to a grain of sand. These yellow masses formed about two-fifths of the contents of the gall-bladder. These masses were soft, and readily crushed between the fingers. Under the microscope, they were found to consist of numerous cells from the mucous membrane of the gall-bladder, and a yellow amorphous matter. The bile-duct appeared to be completely stopped up with these cells, and this yellow amorphous matter. The specific gravity of this specimen of bile was 1036.

In the case of the house painter who died suddenly during convalescence from a severe attack of remittent fever, the bile presented a brownish-yellow color in mass, and a gamboge-yellow color in thin layers. It was tenacious like mucus; in fact, it resembled closely colored mucus, specific gravity 1022.5.

THE LIVER OF THOSE CASES WHICH DIED IN THE ACTIVE STAGES OF MALARIAL FEVER CONTAINED ANIMAL STARCH (GLUCOGENIC MATTER, BERNARD); WHILST HEPATIC SUGAR WAS ENTIRELY ABSENT.

The liver of every fatal case of malarial fever was carefully tested for animal starch and grape sugar, and the results never varied; in intermittent, remittent, and congestive fevers, animal starch (glucogene) was always present, while grape sugar was always absent.

In many cases when the fibrous capsules of the livers were torn off, partially dried, and treated with tincture of iodine, the cellular tissue was not altered by the tincture of iodine, but whenever a particle of liver adhered to the fibrous tissue, these purple and blue masses could be detected with the microscope. In cirrhosed livers the fibrous tissue of the liver generally, and of the portal canals, were found to be completely infiltrated with this animal starch. When single cells of the malarial liver were treated with tincture of iodine, I was not able to demonstrate satisfactorily, whether they contained animal starch. When, however, a number of them in mass were treated with tincture of iodine, the characteristic blue color was produced.

In several cases the hepatic ducts were isolated and treated with tincture of iodine, and carefully examined under the microscope; in some cases the ducts were dotted with blue particles, whilst the other portions were simply changed to the color of the iodine, and in other cases long portions of the hepatic ducts were changed to a bright blue color. These facts show that the hepatic ducts sometimes contain animal starch.

From chemical examinations of the livers of the different forms of malarial fever, from the summer of 1856 to the present time, I have obtained similar results. In many cases the livers were set aside, and examined after intervals of twelve hours; the last examinations were made thirty-six hours after the first; and at every examination the result was the same—the presence of animal starch, without a trace of grape sugar.

The mere presence of starch in the liver is not peculiar to malarial fever; it is not a pathological condition.

In the month of September, 1856, I had an opportunity of examining chemically the liver of a patient, who had been under the care of my friend and former colleague, Dr. J. B. Read. This patient had black vomit, and all the symptoms of yellow fever, and the liver presented the yellow boxwood color peculiar to this disease. Chemical examination gave decided evidence of the presence of animal starch in the structure of the liver. The liver of a yellow fever patient brought from Norfolk by Dr. J. B. Read presented a similar appearance, and also yielded animal starch. I have detected this substance in the human liver, in normal condition after sudden death from diseases of the circulatory apparatus, and apoplexy, and phthisis, and in abnormal states, as cirrhosis, fatty degeneration, and cirrhosis and fatty degeneration combined.

I have examined the livers of numerous vertebrate animals, injected and uninjected, and in every instance animal starch has been found.

Whether the elaboration of this product is confined specially to any one of the anatomical elements of the liver, I have not as yet been able to determine with certainty, for it has been found in the fibrous tissue of the portal canals, in the hepatic ducts, and in several cases, in the lower animals, in the secreting cells. We would naturally infer that it was formed in and by the secreting cells of the liver, and was deposited in other positions by endosmosis. The exact point at which it is converted into grape sugar is unknown. Bernard has shown that this change is due to the action of a special

ferment contained in the blood. Experiments have shown that the liver-cells contain grape sugar as well as the hepatic veins. If the starch is formed in the secreting cells, and grape sugar is formed in them also, then the special ferment of the blood must be absorbed by the secreting cells. A portion of the animal starch may be absorbed by the hepatic veins, and be acted upon by the ferment only partially if in large quantities, and finally be deposited in the organs and tissues.

This view is partially sustained by the fact that this substance is not confined to the liver; for I have found it in considerable abundance in malarial fever spleens, and in normal spleens taken from patients who had died from cirrhosis and fatty degeneration of the liver combined, and in one case where the patient (an aged negro man) had died suddenly from apoplexy. A carbo hydrate, similar in its composition and properties to vegetable cellulose, has been found in some of the lower animals. C. Schmidt[1] discovered cellulose in the mantle of phallusia mammillaris (one of the mollusca), and Lowig[2] and Kölliker have discovered it in the outer tube of salpæ, in the leathery mantle of the cynthiæ, and in the cartilaginous capsule of the simple ascidiæ. The researches of Odier,[3] Lassaigne,[4] Payen,[5] Children,[6] and Danniel, and especially of C. Schmidt,[7] have shown that a body closely resembling cellulose (vegetable fibre), which C. Schmidt regards as composed of a carbo-hydrate, and of a nitrogenous body having the composition of the muscular fibre of insects, forms the true skeleton of all insects and crustacea. This substance, called chitin, constitutes not only the external skeleton, the scales, and hairs of insects, but it also forms their tracheæ, and even one of the layers of the intestinal canal. Cellulose, or animal starch, has been discovered by Rudolph Virchow,[8] in the brain, and in some of the higher nerves of sense. These observa-

[1] Zu Vergl. Physiol. der Wirbellosen Thiere, 1845, S. 62. See also "Contributions to the Comparative Physiology of the Invertebrate Animals, being a Physiologico-Chemical Investigation," by Dr. Carl. Schmidt; Taylor's Scientific Memoirs, vol. v. part xviii., 1852, p. 34.

[2] Ann. de Scienc. Nat., 3d series, tom. v. pp. 193–232.

[3] Mémoire de la Société d'Histoire Naturelle, tom. i. p. 29 *et seq.*

[4] Comptes Rendus, tom. xvi. p. 1087; Journ. de Chim. Méd., 1–9, p. 379.

[5] Comptes Rendus, tom. xvii. p. 227.

[6] Todd's Cyclopædia of Anatomy and Physiology, vol. ii. p. 882.

[7] Zur Vergleichend, Physiol. der Wirbellosen, Thiere. 1845, S. 32–69; trans. in Taylor's Sci. Memoirs, vol. v., 1852, pp. 14–28.

[8] Virchow's Archiv., b. vii., h. i., p. 135.

tions were subsequently confirmed by those of George Busk. In 1853, Virchow[1] announced the discovery of corpuscles, presenting the same reaction as the corpora amylacea of the brain, in the Malphighian corpuscles of diseased human spleens, in the condition termed waxy spleen. Virchow, Bennet, and Carter, have also pointed out the existence of a peculiar amyloid substance in the liver, in some chronic forms of disease, as waxy or fatty degeneration. At a meeting of the Academy of Sciences, March 23, 1857, M. Cl. Bernard announced "that the livers of dogs, fed exclusively on meat, possess the property of forming a glucogenic substance, analogous to vegetable starch, and alike susceptible of an ultimate transformation into sugar, passing through the intermediate condition of dextrine." Sanson, Longet, Bouley, Poggiale, Parry, and others, have recorded similar facts with reference to the occurrence of a substance having very much the same chemical constitution and properties of starch in the liver, and the results of the experiments and researches of Bernard and these observers prove that in herbivorous animals this substance may be found in other organs besides the liver.

The presence of animal starch, and the absence of hepatic sugar, in malarial fever, would seem to indicate that the special ferment in the blood which transforms animal starch into glucose, had been destroyed, whilst the power to manufacture starch from both nitrogenized and non-nitrogenized materials was exercised by the liver, and hence the absence of glucose, and the accumulation of glucogene.

Some of the Points of Difference between the Malarial Fever and Yellow Fever Liver.

The liver of yellow fever, as far as my observations extend, and according to the observations of Louis and many other observers, is of a bright yellow color. It is probable that this color, as in the case of that of the malarial liver, varies with the length of the attack, and the effects of previous diseases. Thus Dr. Samuel Jackson, of Philadelphia, found the livers in cases which had died suddenly in the early stages, engorged with dark blood.

As far as my observation extends, the decoction of the yellow fever liver is of a bright golden color, whilst that of the malarial

[1] Journal of Microscopical Science, No. vi. p. 101.

fever is of a brownish yellow. The golden color of the yellow fever liver can be extracted both by alcohol and water.

The yellow fever liver is much firmer and harder than that of malarial fever, contains much less blood and is much less readily acted upon by liquor potassæ and acids. Liquor potassæ readily dissolves the malarial fever liver, and the decoction presents the appearance of venous blood, while no such effect is produced by the action of this substance upon the yellow fever liver.

Spleen.

The complexity and difficulty of pathological inquiries are again illustrated, by the different views which prevail with reference to the offices of the spleen. Whilst Gerlach, Virchow, and Bennet, consider the spleen as the birthplace of the colored corpuscles, Kölliker, Ecker, Beclard and Gray, consider it the organ in which the blood-corpuscles die and are disintegrated.

The difficulty of settling this question definitely, is increased by the equivocal and uncertain results of comparative anatomical investigations, and of physiological experiments. If the function of the spleen be that of the formation and destruction of the blood-corpuscles, it is reasonable to suppose that it should be much larger in warm than in cold-blooded animals, because the number of the blood-corpuscles is greater, and all the changes of the elements of the fluids and solids much more rapid in the former than in the latter. To determine this point, I ascertained accurately the weights of the bodies and spleens of cold and warm-blooded animals.[1]

The following table presents a condensed view of the results, the accuracy of which I have confirmed again and again, by numerous dissections and comparison of the spleen in the different classes of animals.

Comparative Weights of the Spleens of Animals.

	Fishes.	Number of times the weight of its spleen.
Weight of the body of	Trygon sabina (Stingray), female	292
" "	Trygon sabina (Stingray), fœtus	1016
" "	Zygæna malleus (Hammerhead Shark)	601
" "	Zygæna malleus (Hammerhead Shark)	443
" "	Lepisosteus osseus (Garfish)	587
" "	Lepisosteus osseus (Garfish)	599

[1] "Investigations, Chemical and Physiological, relative to certain American Vertebrata," by Joseph Jones, M. D., Smithsonian Contributions to knowledge, July, 1856, pp. 116–122.

Comparative Weight of the Spleens of Animals—Continued.

		Number of times the weight of its spleen.
	Reptiles.	
Weight of the body of	Rana catesbiana (Bullfrog) . . .	2279
" "	Heterodon niger (Black Viper) . . .	25666
" "	Psammophis flagelliformis (Coachwhip Snake)	6426
" "	Coluber guttatus (Corn Snake) . . .	9600
" "	Coluber constrictor (Black Snake) . .	7285
" "	Crotalus adamanteus (Rattlesnake) . .	15450
" "	Alligator Mississippiensis (Aligator), male	1319
" "	Alligator Mississippiensis (Aligator), female	798
" "	Chelonia caretta (Loggerhead Turtle) .	2201
" "	Chelonura serpentina (Snapping Turtle) .	800
" "	Emys terrapin (Salt-water Terrapin) . .	7958
" "	Emys reticulata (Chicken Terrapin) . .	965
" "	Emys serrata (Yellow-bellied Terrapin) .	1618
" "	Emys serrata (Yellow-bellied Terrapin) .	1125
" "	Testudo polyphemus (Gopher) . . .	2575
" "	Testudo polyphemus (Gopher) . . .	3600
	Birds.	
Weight of the body of	Meleagris gallopavo (Wild Turkey), female	1538
" "	Meleagris gallopavo (Wild Turkey), female	2625
" "	Picus erythrocephalus (Red-headed Woodpecker)	2120
" "	Tantalus loculator (Wood Ibis) . .	3579
" "	Tantalus loculator (Wood Ibis) . .	2044
" "	Syrnium nebulosum (Barred Owl) . .	1470
" "	Cathartes atratus (Black Buzzard) . .	1228
	Mammals.	
Weight of the body of	Didelphis Virginianus (Opossum) . .	418
" "	Common Sheep	590
" "	Sciurus Carolinensis (Gray Squirrel) .	682
" "	Sciurus capistratus (Fox Squirrel . .	919
" "	Cervus Virginianus (Fœtus of Deer) . .	283
" "	Cervus Virginianus (Fœtus of Deer) . .	350
" "	Mus rattus (Rat just born) . . .	498
" "	Mus rattus (Rat just born) . . .	505
" "	Mus rattus (Rat half grown) . . .	506
" "	Lepus sylvaticus (Common Rabbit) . .	1494
" "	Procyon lotor (Raccoon), female . .	343
" "	Procyon lotor (Raccoon), female . .	292
" "	Procyon lotor (Raccoon), female . .	391
" "	Procyon lotor (Raccoon just born) . .	156
" "	Pointer Dog, male	577
" "	Common Cat, female	522

These tables show that the spleen is smallest in birds and ophidians, and largest in fishes and mammals.

The temperature of birds is high, their blood-corpuscles numerous, their life actions vigorous, and the physical and chemical changes of the elements of their fluids and solids correspondingly rapid. In fishes, circulation and respiration are sluggish, the blood-corpuscles few in numbers, the temperature low, the metamorphosis of the elements of their structure slow, and the intellect and all the life actions correspondingly feeble. If the function of the spleen be the construction, destruction, and elaboration of some of the important elements of the blood, why is it so small and insignificant in birds, and of such great relative magnitude in many cold-blooded animals?

Is it possible that an organ, which, in many ophidians, chelonians, and birds, weighs only a few grains, or a small fraction of a grain, can exert any important influence upon the physical properties and chemical constitution of the blood? Do not these facts show conclusively that we do not understand the functions of the spleen?

Mr. Gray[1] supposes that one office of the Malpighian corpuscles is to store up nutritive matter when there is a surplus of alimentary materials, to be restored again to the blood when there is a deficiency of these elements. It is, however, difficult to conceive how nutritive matter of any importance could be stored up in the Malpighian corpuscles of organs weighing a few grains, or only fractions of a grain. The amount accumulated in such organs would be microscopic in its character, and not much more than the hundredth part of a grain. Even in warm-blooded animals, the amount of albuminous compounds contained in the Malpighian corpuscles of the spleen is insignificant, and unworthy of notice, when compared with that contained in the circulatory apparatus, the capacious reservoir of the nutritive materials. The circulatory apparatus of an adult man contains about twenty pounds of blood, whilst the Malpighian corpuscles of the spleen are capable of containing only a few grains. Would nature construct an organ, an important office of which would be to store up a few grains of nutritive matter, whilst the circulatory system contains more than ten thousand times the amount?

My observations show that the increase of the spleen during active nutrition noticed by Mr. Gray in cats, rabbits and rats, is by

[1] The Structure and Use of the Spleen, by Henry Gray, F.R.S. London, 1854.

no means a universal phenomena in the animal economy. The spleens of ophidians and saurians and chelonians did not diminish in weight more rapidly than the other organs and tissues, and the spleens of salt-water terrapins (*emys terrapin*), and of yellow-bellied terrapins (*emys serrata*), which had been starved and deprived of water for a great length of time, and then transferred to a tub of water and abundantly supplied with vegetable food, did not exhibit any increase in weight. I have also observed, in numerous instances, that the spleen of cold-blooded animals does not act as a diverticulum for any surplus water or nutritive materials in the circulatory apparatus. The spleens of many carnivorous chelonians, whose circulatory apparatus was so filled with blood, consequent upon a change of diet, that aqueous albumino-saline effusions took place into the cellular tissue, and all the cavities presented no increase in size or weight. The spleens of ophidians, which are voracious and swallow large masses of flesh, were not enlarged, notwithstanding the large amount of nutritive substances which were received into their circulatory apparatus.

That the spleen is an organ of subordinate importance in the animal economy, will be shown by the following facts: It is absent from all invertebrate animals without exception. It is also absent from the amphioxus, the connecting link between fishes and the higher forms of the mollusca.

The spleen of birds and reptiles is too small to exert an important influence in the animal economy. Its size corresponds in no manner with the number of colored blood-corpuscles, or the rapidity of the composition and decomposition of the organic and inorganic elements of the solids and fluids of animals.

The function of the spleen is not essential to the maintenance of life, for it has been excised by numerous observers, without the death of the animal, or any manifest alterations in the blood or organs, or any diminution of the forces.

On the other hand, that the spleen has some important office to perform in the animal economy, is shown by the fact that in the amphioxus and invertebrate animals, which are devoid of spleens, the blood-corpuscles are colorless. The occurrence of the spleen is accompanied by a change in the color of the blood. The question immediately arises, has the spleen anything to do with the production of the red blood-corpuscles of vertebrate animals? The blood of the invertebrata, with its corpuscles, exists before the formation of any special organs; and the same fact is noticed in the develop-

ment of the fœtus of warm-blooded animals; a vascular system circulating a fluid containing colored blood-corpuscles exists before the formation of any special organs; and hence it is probable that the spleen has little to do with the formation of the corpuscles and the production of their red color. This question cannot, however, be settled by an appeal to comparative anatomy, or by extirpation of the spleen, because it is more than probable that other organs possess the power of performing the offices of the spleen when it is absent.

Besides these facts in comparative anatomy, the microscopical examinations of the pulp of the spleen by Oesterlen, Remak, Handfield Jones, Kölliker, Ecker, Beclard, and Gray, and the comparative analysis of the blood entering in the spleen, and of that passing out of these organs, render it highly probable, if not absolutely certain, that one of the most important offices of the spleen is the destruction of the colored blood-corpuscles.

As, therefore, our knowledge of the functions of the spleen is not as extensive or as definite as the requirements of exact science demand, we should exercise caution in the construction of theories, with reference to the effect of pathological alterations of the spleen in diseases.

Weight of the Spleen in Malarial Fever.

The following table confirms the statements of numerous observers, that the spleen is enlarged in malarial fever.

Weight of the Spleen in Malarial Fever.

	Avoirdupois pounds.	Avoirdupois ounces.	Troy grains.
Weight of the spleen in its normal condition	...	...	3062 to 2187
Case of intermittent fever in latter stages of phthisis	...	14½	6343
" remittent and typhoid fever	1 lb. 2 ozs.	18	7920
" remittent fever	1 " 15 "	31	13562
" remittent fever	1 " 13 "	29	12687
Two years after attack of remittent fever	1 " 14½ "	30½	13343
Case of remittent fever	1 " 2½ "	18½	8093
" congestive fever	...	13½	5895
" congestive fever	1 " 13 "	29	12687
" congestive fever	1 " 1½ "	17½	7562

This table shows that in seven cases of malarial fever, terminating in the active stages, the spleen was enlarged; the enlargement,

however, was not so great as in those cases exposed to a longer action of the malarial poison. In such cases the spleen is often greatly enlarged, and can be often felt during life as a hard mass occupying a considerable portion of the abdominal cavity. Cases are recorded where the spleen has been said to weigh twenty pounds.

I have found the spleen of those who died in the active stages of malarial fever, not only enlarged, but softened, and filled with dark brownish-purple, and brownish-red mud.

The malarial spleen presents upon the exterior, a dark slate color; and the trabeculæ and capsule appear to be completely altered in structure; so much altered in many cases, that the slightest touch is sufficient to rupture them. I have seen the structures of the spleen in malarial fever so much disorganized, that in attempting, even in the most careful manner, to remove this organ from the abdominal cavity, the trabeculæ have given way under a slight pressure, and the fingers plunged into its soft substance.

The dark brownish-purple mud (pulp and extravasated blood) of the spleen is composed, in great measure, of colored blood-corpuscles, altered in various degrees, according to the length of the attack, and which have lost the power of changing to the arterial hue when exposed to the oxygen of the atmosphere. In many cases, especially those of long standing, the pulp and extravasated blood (mud), of the spleen abounds in dark reddish-brown, and reddish-black granules and conglomerated granules, resembling the dark particles found in the malarial liver, and in the sediment of the black-vomit of yellow fever. Similar bodies, but apparently in less abundance, are found in normal spleens. In cases which have terminated fatally, after only a short illness of two or three days, these bodies resulting from the disintegration of the colored blood-corpuscles, were not so numerous as in cases of longer duration, and in some very recent cases, they were not more numerous than in the spleen of health. We will now illustrate the changes of the spleen in malarial fever, by cases of varying duration.

In a case of malarial fever of the congestive type, of only forty-three hours' duration, the spleen was slate-colored, softened, and enlarged; not as much softened and altered, however, as in cases of malarial fever of longer standing. The mud of the spleen was of a dark purplish hue, and appeared to be in transition to the color and state of the mud of the spleens of malarial fever of longer duration. After exposure for a few hours to the oxygen of the atmosphere, a large portion of the mud of the spleen assumed a color approach-

ing the arterial hue; much brighter than the mud of the spleens upon which malarial fever had exerted its full effects, and somewhat darker than the bright arterial hue, assumed by the splenic pulp of healthy normal spleens. When the mud was spread in thin layers upon a glass slide, the change of color was much more rapid. Under the microscope, the splenic mud appeared to consist almost entirely of colored corpuscles, many of which appeared swollen and altered in appearance. After careful examination, I was unable to find those conglomerations of black granules, resembling the black sediment of black vomit, which were discovered in the spleens of malarial fever of longer standing.

The spleen of a stout Irish seaman, who died from an attack of congestive fever, fifty hours after the first appearance of disease, was enlarged, softened, disorganized, and of a dark slate-color; and when pressed gently between the fingers, the trabeculæ could be felt giving way. The cut surface presented a dark, purplish-brown color; from the cut surface issued a dark, purplish-brown mud. After eight hours' exposure to the atmosphere small streaks, inclining to an arterial hue, appeared upon the cut surface of the spleen, and probably were due to the change in the blood which issued from the divided vessels. These streaks of splenic mud, inclining to the arterial hue, occupied but an inappreciable fraction of the whole surface. When the dark mud (effused blood) was examined under the microscope, it was found to consist chiefly of colored and colorless corpuscles, and the cells peculiar to the spleen. Some of the colored corpuscles were swollen and altered in shape; the alteration was by no means universal or remarkably great. This spleen contained, as usual in malarial fever, animal starch.

The spleen of an American seaman, who died of congestive fever seventy hours after the first appearance of disease, was enlarged, softened, and of the dark slate-color usual in malarial fever. When the mud of the spleen was exposed to the atmosphere, a part retained the dark-purplish and reddish-brown color; whilst another smaller portion changed to an arterial hue. The difference between these two portions of the splenic mud were clearly seen when a section of the organ was exposed for several hours to the action of the atmosphere. The other portion of the mud of the spleen did not change its color. This phenomenon was, without doubt, due to the fact that the blood had been but recently effused into the spleen. The portions first effused had lost the power of changing to the arterial hue; whilst those last effused had not entirely lost this power.

The spleen of an Irish laborer, who died suddenly in a congestive chill, which had been preceded for three or four days by an apparently mild attack of intermittent fever, was slate-colored, enlarged, softened, and disorganized, and could not be removed from the abdominal cavity without rupture of its capsule and trabeculæ. The capsule and trabeculæ appeared to be so altered in structure that the slightest touch was sufficient to rupture them. After careful washing under a stream of cold water the trabeculæ, as usual in malarial fever, presented a red color. The mud of the spleen was of a dark-reddish and purplish-brown color, and consisted principally of colored blood-corpuscles, which did not change to the arterial hue during fifty hours' exposure to the oxygen of the atmosphere. The mud and fibrous tissue of the trabeculæ and blood-vessels of this spleen contained animal starch.

The spleen of a large, stout German laborer, who died of congestive fever, supervening upon an attack of malarial fever of four days' continuance, was enlarged and disorganized, and presented a dark slate-color. To the touch the spleen felt like a sack filled with a viscid fluid. The capsule was torn upon the slightest exertion of force. Whilst gently lifting the spleen, to sever its attachments and lift it out of the abdominal cavity, the capsule was torn off for the space of several inches, and my fingers, which grasped the organ, plunged through the disorganized trabeculæ and pulp. When the spleen was laid upon the table and pressed, the mud within was forced into other portions, and the indentation remained, thus showing that the cells of the spleen communicated freely with each other. The spleen was filled with a substance resembling purplish-black mud. This splenic mud was very thick, and dried rapidly when spread upon glass slides. Under the microscope, this was found to consist principally of colored blood-corpuscles. Many of the colored blood-corpuscles presented an altered appearance. In some cases the color appeared darker than normal. Many of the corpuscles were swollen; whilst others were corrugated. That the colored corpuscles had undergone some change was conclusively demonstrated by the fact, that the color of this splenic mud did not alter during thirty-six hours' exposure to the oxygen of the atmosphere. The splenic mud also contained numerous dark granules and granular masses. The number of colorless corpuscles were apparently diminished. This diminution was in all probability relative and not absolute; they appeared to be diminished relatively to the immense number of colored blood-corpuscles.

The spleen of an Irish seaman, who died ten days after the onset of remittent and congestive fever, was of a dark slate-color, and enlarged, softened, and the capsule and trabeculæ gave way when pressed gently between the fingers. When first removed, the mud of the spleen coagulated very slightly; the coagulum possessed no consistency and no permanence. When the pulp and extravasated blood of the spleen were examined under the microscope, it was found to consist of colored and colorless blood-corpuscles, and numerous dark, black granules. These granules were frequently conglomerated together, forming dark flakes, like the coffee-ground sediment of the black vomit of yellow fever. Many of the colored corpuscles appeared swollen.

The spleen of an Irish laborer, who died two weeks after an attack of intermittent fever from congestion of the brain, was enlarged, softened, and of a light slate-color. The pulp of the spleen was of a purplish and reddish-brown color, and changed to the arterial hue upon exposure to the atmosphere.

The spleen of an Irish baker, who died during convalescence from remittent fever during an attack of pleuro-pneumonia, was slate-colored, enlarged, and softened. The pulp of the spleen was firmer than that of recent cases of malarial fever, and although it changed to the arterial hue more slowly than the pulp of healthy spleens, the change of color was much greater than that of the pulp of the spleen in the active stages of malarial fever.

The spleen of a house painter who had died in convulsions, three weeks after an attack of remittent fever, was enlarged and softer than normal, but much harder than usual in the active stages of malarial fever. The cut surface presented a compact, dark brown almost black appearance. Numerous small white bodies, about the size of millet-seed, were found scattered through the pulp of the spleen. I had never before seen the splenic corpuscles so numerous, large, and distinct. The exterior of the spleen was of a slate color. The compact nature of the pulp of this organ shows that it was recovering from the effects of malarial fever.

The spleen of the German butcher, who suffered with intermittent fever two months, without medical treatment, and whose disease at the end of this time assumed the congestive type, and although relieved of the immediate effects of the malarial poison, fell a victim, after three weeks of the most intense and loathsome suffering, to the complete disorganization of the solids and fluids resulting from the pathological alterations induced by the malarial poison during

the period when it pursued its course unchecked; presented profound alterations. This organ was enlarged; surface covered with effused coagulable lymph, and bound to the liver and diaphragm by bands of coagulable lymph. A large quantity of pus, of a greenish-yellow color, issued from the anterior border of the spleen, which was firmly attached to the liver. Whether the abscess had opened and discharged the pus before death, or whether the abscess was accidentally ruptured during the opening of the chest and abdomen, I was unable to determine.

The structure of the spleen felt firm, very unlike the soft yielding structure of the spleen of the active stages of malarial fever. When cut, many portions of the spleen resembled a dark bronzed and slate colored liver. The pulp of these portions was not soft, and did not pour out like the pulp of the spleen of the active stages of malarial fever.

The liver-like substance of the spleen was found to consist under the microscope of fibrous tissue, and numerous colored corpuscles and flakes, composed of granules resembling the dark colored flakes of the black vomit of yellow fever. These flakes were without doubt derived from the coloring matter of the colored blood-corpuscles. The colorless corpuscles of this portion of the spleen appeared to be more numerous than usual. This dark liver-like substance appeared to be nothing more than the extravasated blood and the pulp of the spleen, effused and altered during the active stages of the fever, from which the serum has in a great measure been removed, and in which alterations of the colored corpuscles have taken place, and fibrous tissue formed. After several hours' exposure to the oxygen of the atmosphere, the color of this portion of the spleen was not altered. In addition to the abscess opening upon the surface of the spleen attached to the liver, the substance of the spleen contained numerous smaller abscesses of various sizes (two or three of the largest were of the size of a bullet, and the smallest of the size of an English pea), filled with thick greenish-yellow pus. Portions of the spleen, especially surrounding the abscesses, were altered into a cheese-like substance. Under the microscope, these cheese-like portions consisted almost entirely of pus-corpuscles, and large cells containing granules and other smaller cells; and also black masses composed of granules, and also numerous oil-globules. The large mother cells, resembling cancer-cells, were not numerous. The pus issuing from the large abscess

resembled ordinary pus under the microscope, and contain a few of these peculiar cancer-like cells.

The spleen of an American, who died from the formation of heart-clots, consequent upon structural disease of the heart and liver, and who had suffered with an attack of malarial fever two years previous to his death, whilst residing upon the Ogeechee River, in a low, miasmatic situation, was enlarged and indurated, and presented a purplish-red color. When pressed in the hand, it felt dense and firm. When cut or torn, the color and structure resembled that of healthy spleens in all respects, except that it had a much larger quantity of fibrous tissue. The pulp of the spleen absorbed oxygen readily when exposed to the atmosphere, and changed to a bright scarlet color. The pulp of the spleen presented nothing peculiar under the microscope. Did not discover those black flakes and granules which were so abundant in the spleen of the patient previously described. This spleen contained animal starch.

It is reasonable to suppose that the enlargement and induration of this spleen were the effects of the previous attack of malarial fever. During the active stages of the fever the spleen was engorged with blood, softened, and the trabeculæ in many places ruptured. When the action of the malarial poison ceased, the serum of the extravasated blood was removed, and the ruptured trabeculæ repaired, and numerous bands of fibrous tissue formed throughout its substance. Finally the colored corpuscles of the extravasated blood were disintegrated and removed.

These cases demonstrate that the alterations of the spleen occur amongst the first pathological effects of the malarial poison.

The gradual enlargement of the spleen in the bodies of those inhabiting malarious districts, without any distinctly marked febrile symptoms, shows that these alterations of the spleen may precede the active symptoms, and those disturbances of the nervous system attending the cold and hot stages of malarial fever.

These cases demonstrate that the alterations of the spleen in malarial fever are of the most decided and serious character. The spleen might be readily ruptured, either by violent exercise or by blows, or even by rough handling, during the active stages of malarial fever.

An immense number of colored blood-corpuscles are destroyed in the spleen during the active stages of malarial fever. The effused colored corpuscles are gradually disintegrated; their hæmatin appears as dark granular masses, which are gradually altered physically and

chemically, passing through several shades of color, and are finally eliminated. The serum of the effused blood is also removed; fibrous bands or trabeculæ are formed through the extravasated blood, the capsule is thickened, and gradually the organ becomes firm and assumes its normal structure and offices.

The cause of the peculiar pathological alterations of the spleen in malarial fever appears to depend upon the alterations of the blood and circulation, which produced similar congestions in the brain and liver, and upon the peculiar anatomical structures of the spleen. We have before shown that the fibrin of the blood is diminished and altered in malarial fever, and that the relations between the general and capillary circulations, and between the constituents of the blood and the walls of the vessels, are disturbed, and that the chemical changes upon which the capillary circulation depends are perverted and diminished, and that the action of the heart is greatly disturbed. Here, then, we have causes sufficient to account for the stagnation of the blood in the important organs of the trunk, and especially in the spleen, on account of its anatomical relations to the other organs of the abdomen, the absence of valves in the splenic veins, and their communication with the intercellular spaces of the spleen-pulp. Mr. Gray has shown that many of the capillary vessels are not directly continuous with the veins, but that the blood, in passing from one set of vessels to the other, traverses intercellular spaces in the spleen-pulp, and that the veins in many cases commence in intercellular spaces.

If these views are correct, it follows as a necessary consequence that the pathological alterations of the spleen in malarial fever are not the result of inflammatory action.

The red color of the trabeculæ, after the pulp has been washed out, has nothing to do with inflammation, and is the result of the action of the coloring matter of the disintegrated blood-corpuscles, and is analogous in all respects to the staining of the endocardium and large vessels by imbibition of hæmatin, in many diseases entirely unaccompanied by inflammation.

Pancreas.

We have been unable to detect any alteration in the pancreas peculiar to malarial fever.

Kidneys.

In several cases of malarial fever, and in two which had yielded suddenly in the earliest stages, the kidneys presented slate-colored spots, which presented a bronze color upon section to the depth of one-fourth to one-eighth of an inch. Microscopical examination demonstrated that the black granules were not present in these bronzed portions, and that the structures of the kidney were not altered in any recognizable manner. We have in a previous chapter considered the bearing of this fact upon the slate and bronze color of the liver.

CHAPTER VI.

CIRCULATION, RESPIRATION, TEMPERATURE, STATE OF THE SKIN, TONGUE, AND CHANGES OF THE URINE IN INTERMITTENT, REMITTENT, AND CONGESTIVE FEVER.

Principles of Treatment based upon these Observations.

The complete investigation of pathological phenomena demands the accurate determination of the amounts and chemical relations of all the materials entering into the diseased body, and of the transformations through which these materials pass, and of the amounts eliminated, and of the chemical and physical forms and conditions under which they are eliminated; demands the accurate determination of the chemical changes of the constituents of the organs, tissues, apparatus, and blood, and of the forms and conditions under which they are eliminated.

The pathologist has no means of determining the character of the chemical changes going on in the living body during the different stages of disease.

The pathologist is limited to an examination of the forces developed by these changes, and of those products resulting from these changes, which are eliminated and cast off from the body.

Although it is impossible in the present state of science to deter-

mine accurately the amounts of the muscular and nervous forces, and of heat generated during the stages of diseases, still an examination of the mutual relations and disturbances of these forces during the progress of disease, yields invaluable information bearing upon the nature and treatment of diseases. The amount of force generated in the living body, no matter in what peculiar form or mode of force it appears, always stands in direct relation with the amount of matter chemically altered. The great laws of action and reaction, and of the indestructibility of force, apply, as we have before demonstrated, to all the forces which work the animal machinery.

We have instituted, and are still prosecuting, a series of experiments, the object of which is the demonstration that all the forces of animals, physical, chemical, muscular, and nervous, are derived from the chemical changes of the elements entering into their bodies as food, and forming their structures.

The following observations demonstrate, as far as they extend, that the forces of animals are developed by a chemical change of the elements, and are proportional to the amount of chemical change:—

Table showing the Loss of Weight, and Amount of Urine excreted by Cold and Warm-Blooded Animals deprived of Food and Drink.

NAME OF ANIMAL.	Duration of starvation and thirst.	Weight before starvation and thirst.	Weight after starvation and thirst.	Loss of weight during starvation and thirst.	Loss of weight, expressed in a fraction of the original weight.	Loss of weight each hour.	Loss of weight each hour, expressed in a fraction of the original weight.	Amount of urine excreted during thirst and starvation.	Amount of urine excreted, expressed in a fraction of the original weight.	Am't of urine excreted hourly.	Am't of urine excreted hourly, expressed in a fraction of the original weight.	Am't of the solid constituents of urine excreted hourly.
		Grains.	Grains.	Grains.		Grains.		Grains.		Grains.		Grains.
Emys Serrata . . .	14 dy's	20873	18756	2117	$\frac{1}{10}$	6.300	$\frac{1}{3313}$	442	$\frac{1}{47}$	1.315	$\frac{1}{15865}$	.00340
" . . .	20 "	34155	28675	5480	$\frac{1}{6}$	11.410	$\frac{1}{2994}$	113	$\frac{1}{302}$	.0235	$\frac{1}{1453340}$	.00187
" . . .	20 "	41086	34960	6126	$\frac{1}{7}$	12.760	$\frac{1}{3298}$	741	$\frac{1}{55}$	1.543	$\frac{1}{26627}$	.00611
" . . .	26 "	30132	22760	7372	$\frac{1}{4}$	10.500	$\frac{1}{2870}$	223	$\frac{1}{135}$	.357	$\frac{1}{846500}$	.00166
" . . .	34 "	38590	30142	8398	$\frac{1}{4}$	10.290	$\frac{1}{3754}$	890	$\frac{1}{44}$	1.090	$\frac{1}{35357}$	.00457
" . . .	45 "	17797	14400	3397	$\frac{1}{5}$	3.140	$\frac{1}{5667}$	300	$\frac{1}{59}$	.027	$\frac{1}{642130}$	.00120
Emys Terrapin . . .	38 "	14285	11400	2885	$\frac{1}{5}$	3.317	$\frac{1}{4366}$	300	$\frac{1}{47}$	.032	$\frac{1}{446406}$	.00114
" . . .	43 "	18832	13485	5347	$\frac{1}{3}-\frac{1}{4}$	5.180	$\frac{1}{3635}$	70	$\frac{1}{269}$	.006	$\frac{1}{2810731}$	
" . . .	56 "	12280	9255	3025	$\frac{1}{4}$	2.250	$\frac{1}{5458}$	130	$\frac{1}{94}$	.009	$\frac{1}{1279162}$	.00059
Female Emys Terrapin	38 "	14285	11400	2885	$\frac{1}{5}$	3.317	$\frac{1}{4366}$					
" "	56 "	12280	9255	3025	$\frac{1}{4}$	2.250	$\frac{1}{5458}$					
Female Emys Serrata	12 h'rs	33417	33258	159	$\frac{1}{200}$	13.250	$\frac{1}{2728}$					
" "	14 d'ys	20873	18756	2117	$\frac{1}{10}$	6.300	$\frac{1}{3313}$					
" "	20 "	34155	28675	5480	$\frac{1}{6}$	11.410	$\frac{1}{2994}$					
" "	20 "	41086	34960	6126	$\frac{1}{7}$	12.760	$\frac{1}{3298}$					
" "	39 "	38590	30142	8398	$\frac{1}{4}-\frac{1}{5}$	10.290	$\frac{1}{3754}$					
Male Emys Serrata .	45 "	17797	14400	3397	$\frac{1}{5}$	3.140	$\frac{1}{5667}$					
6 Emys Serrata . .	27 "	104698	85573	19125	$\frac{1}{5}-\frac{1}{6}$	27.970	$\frac{1}{3743}$					
Testudo Polyphemus	25 "	18368	16922	1446	$\frac{1}{13}$	2.410	$\frac{1}{7621}$					
4 " "	39 "	98280	86696	11582	$\frac{1}{9}$	13.040	$\frac{1}{7536}$					
Cur Dog	6d. 14h.	161326	112055	49271	$\frac{1}{3}$	311.840	$\frac{1}{517}$					
Ardea Candidissima (*White Crane*) . .	7 8	4905	2811	2094	$\frac{10}{23}$	28.430	$\frac{1}{172}$					
" "	1 5	4835	4044	835	$\frac{10}{56}$	28.800	$\frac{1}{135}$					

These observations, which I have extended to numerous other warm and cold-blooded animals, and to man, together with an examination of the structure and development of the circulatory and respiratory apparatuses of the animal[1] kingdom, support the following conclusions:—

The intellect, temperature, nervous, and muscular forces, and organic development of animals, are in proportion to the rapidity of the changes of the elements. In warm-blooded animals, which are endowed with intellect of a high order, and possess great nervous and muscular force, and correspondingly developed organs, the changes in their elements are incessant. When starved they lose weight rapidly. In cold-blooded animals, the temperature of which is often below the surrounding medium, and whose nervous system and intellect are feebly developed, the changes in their elements are correspondingly slow. The cur dog lost in six days and fourteen hours one-third of its original weight; whilst the chelonians lived from thirty to sixty days without losing more than from one-fourth to one-thirteenth of their original weight. The loss in the former was from six to fifteen times more rapid than in the latter. The loss of weight at the time of death was very nearly equal in warm and cold-blooded animals. The maintenance of the short, vigorous life of the former required as large a supply of organic and inorganic materials as the prolonged existence of the latter. What the warm-blooded animal gained in intensity and power, it lost in duration.

The length of the life of an animal during starvation and thirst, is proportional to the rapidity of the changes of its elements, and, as a necessary consequence, stands in direct relation to its temperature, intellect, and organic development. Warm-blooded animals wasted more rapidly, lived more energetically, and died in a correspondingly shorter time than cold-blooded animals. Amongst cold-blooded animals the chelonians, which were most active in their movements, and whose nervous system was most excited, lived during a time corresponding with their increased nervous and muscular exertions. The female terrapins, whose ovaries and oviducts were filled with hard and soft eggs, lost from $\frac{1}{27.28}$ to $\frac{1}{33.13}$ of

[1] For numerous experiments on this subject, see the author's investigations, published by the Smithsonian Institution—"Investigations, Chemical and Physiological, Relative to Certain American Vertebrata," by Joseph Jones, M.D.; Smithsonian Contributions to Knowledge, 1856.

their weight hourly, and died in the course of twenty-five or thirty-five days; while the females which had deposited their eggs, and the males, which were frec from these anxieties, wasted only one-half as much per hour—$\frac{1}{4366}$ to $\frac{1}{5667}$ of their whole weight—and lived twice the length of time—from fifty to seventy days.

As the acts of life are carried on in thc same general manner in all animals, and as each species and individual has its own peculiar, intellectual, and physical endowments, it follows, as a necessary consequence, that each species and individual, whether belonging to the animal kingdom or to the human race, must have its own amount of chemical change, which develops the forces. The forces developed by these chemical changes are dependent upon the amount of matter chemically altered, and the position and manner in which it is altered. Here is a wide and important field for investigation, as yet almost entirely untrodden.

These facts, although imperfect, are sufficient to demonstrate the necessity in every pathological investigation, of determining the amount of matter chemically altered and thrown off, and the characters of the matters thus eliminated. This can only be accomplished by the determination of the amounts and characters of the matters thrown off from the lungs, skin, kidneys and bowels. We know that it is almost impossible, with the present instruments and methods of investigation, to determine accurately, the changes in quantity of carbonic acid gas thrown off from the lungs under different circumstances of health, during long periods of time, and the difficulties are greatly increased when we attempt to determine the quantity and characters of the excretions of the skin. Any observations with the present instruments and methods of investigations upon the amounts of matter thrown off from the lungs and skin, for long periods during different diseases, must be unsatisfactory if not absolutely impracticable. Happily the pathologist can examine the urine which reflects as in a mirror, the changes going on in the body, and can determine the relations and changes of the animal temperature, circulation, and respiration.

We hope to demonstrate hereafter, by numerous careful observations, that the determination of the relations of the circulation, respiration, and temperature in diseases, is of the greatest importance in enabling the practitioner of medicine to understand the nature and treatment of diseases, and predict with a great degree of certainty, their course and termination. Thus, whenever, as in congestive fever, there is a want of correspondence between the

circulation, respiration, temperature, and chemical changes, the patient is always in danger. A patient with a rapid feeble pulse, and rapid thoracic respiration and low temperature (sluggish chemical changes), is always in great danger. A full moderately rapid pulse, and moderately rapid and full respiration, and correspondingly high temperature, are always favorable symptoms, provided there be no complications, as congestion of the brain. The severity of malarial fever is by no means proportional to the height of the fever (animal temperature). As a general rule, the higher the fever (temperature), the more readily does the attack yield to treatment, and the less serious the effects. High temperature signifies active chemical changes, and an effort on the part of nature to break up and consume the poison, and a power of resistance. It is the want of a high temperature which is the most dangerous symptom in malarial fever.

It is necessary that we should in the first place establish standards of the action of the respiratory and circulatory apparatus and of the animal temperature of the different parts of the body in health, to which the changes in disease may be referred.

The following observations are valuable, because they were all taken with the same instrument, in the same hospital, and under as similar circumstances as I could devise. In their determination I used every precaution necessary to accuracy:—

Table showing the Variations of the Pulse, Respiration, and Temperature of Different Individuals.

Age.	Sex.	Date.	REMARKS, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.
18	M.	July 15	Healthy, active young man; American; student of medicine; sanguine temperament; standing posture, after exercise.	78	20	82.1°	99.0°	99.5°
20	M.	July 15	Healthy young American physician; sanguine temperament; standing posture, after exercise.	68	20	82.0	98.0	99.5
12	M.	..	Negro boy, healthy and active: erect posture, after exercise.	88	21	82.0	97.0	99.5
24	M.	..	Healthy, active young man; lying in bed just after waking in the morning.	76	15	45.0	95.0	98.0
22	M.	Oct. 5	Seaman; during convalescence from intermit. fever.	62	21	70.0	96.0	99.33
27	M.	..	English seaman; recumbent posture.	64	16	78.0	98.0	99.0
25	M.	..	Irish seaman; recumbent posture.	60	17	83.0	97.0	98.8
25	M.	..	Seaman; recumbent posture; during convalescence from remittent fever.	44	22	84.0	97.8	99.12
14	M.	..	Irish seaman; recumbent posture.	57	16	81.0	98.0	99.5
44	M.	..	Baker and cook; right arm and leg somewhat paralyzed.	..	..	82.0	99.0	100.2
26	M.	Sept. 25	Stout American seaman.	62	14	76.0	98.0	99.25
26	M.	Oct. 8	Do. do.	48	14	73.0	97.0	99.5
23	M.	Oct. 9	Do. do.	43	15	72.0	96.5	99.75
20	M.	..	English seaman; shortly after recovering from an attack of intermittent fever.	72	17	84.5	98.7	99.9
30	M.	July 6	American seaman; slight paralysis of one hand, but otherwise healthy.	..	..	88.0	96.5	99.0
30	M.	July 9	Do. do. do.	..	..	81.0	97.5	99.0
27	M.	July 6	Portuguese sailor; suffering from injury of spine; health otherwise good.	..	..	79.0	98.5	99.0
27	M.	July 9	Do. do. do.	..	..	83.0	98.0	99.0
50	M.	July 7	Stout English seaman.	..	..	84.5	96.0	99.7
20	M.	July 9	Do. do.	60	16	81.5	98.0	98.9
48	M.	July 1	American; stout, well built; suffering with partial paralysis of right side; health otherwise good.	..	..	82.5	96.5	99.2
24	M.	..	Irish laborer.	..	..	82.0	98.0	99.25
30	M.	July 8	Irish laborer; paralysis of right leg from blow, but otherwise healthy.	..	..	80.0	98.0	99.5
18	F.	July 15	Stout Irish woman; subject to fits of partial insanity; apparently in perfect health.	84	..	79.0	92.0	98.0
30	F.	Aug. 7	American woman; superior portion of body in perfect health; chest and arms well developed; lower extremities atrophied; general health good.	..	..	80.5	97.5	100.1
45	M.	Oct. 19	American seaman in erect posture, after walking.	20	60	71.5	96.0	99.0

The following tables are drawn up from the observations of Dr. John Davy, whose elaborate and valuable researches afford the best materials for the establishment of the limits of the variations of the pulse, respiration, and temperature in health:—

Variation of Temperature during 24 hours. Mean of Daily Observations for one year in England and one year in Barbadoes. By JOHN DAVY, M. D.[1]

MEAN TEMP. UNDER TONGUE.			PULSE.			RESPIRATIONS.			TEMPERATURE OF ROOM.		
7–8 A. M.	3–4 P. M.	12 P. M.	7–8 A. M.	3–4 P. M.	12 P. M.	7–8 A. M.	3–4 P. M.	12 P. M.	7–8 A. M.	3–4 P. M.	12 P. M.
98.74°	98.52°	97.92°	57.6	55.2	54.7	15.6	15.4	15.2	50.9°	54.7°	62.0°

IN BARBADOES—

MEAN TEMP. UNDER TONGUE.			PULSE.			RESPIRATIONS.			TEMPERATURE OF ROOM.		
6–7 A. M.	12–2 P. M.	9–11 P. M.	6–7 A. M.	12–2 P. M.	9–11 P. M.	6–7 A. M.	12–2 P. M.	9–11 P. M.	6–7 A. M.	12–2 P. M.	9–11 P. M.
98.07°	98.9°	99.0°	54.4	56.0	60.3	14.4	15.4	15.0	76.7°	83.6°	79.0°

Variations of Temperature during different Seasons of the Year. By JOHN DAVY, M. D.[2]

MONTH.	Mean temp. under tongue.	Air of room.	MONTH.	Mean temp. under tongue.	Air of room.
1845			1847		
July	98.43°	76.00°	January . . .	98.60°	77.70°
August	98.30	80.60	February . . .	98.53	80.26
September . .	98.60	81.20	March	98.60	77.40
October . . .	98.56	81.46	April	98.53	78.00
November . . .	98.46	80.56	October . . .	98.66	80.83
December . . .	98.40	77.90	November . . .	98.56	79.66
			December . . .	98.36	77.36
1846			1848		
January . . .	98.63	78.16	January . . .	98.60	77.06
February . . .	98.60	77.88	February . . .	98.53	77.73
April	98.46	80.00	March	98.60	78.40
May	98.66	81.50	April	98.60	78.26
June	98.66	81.56	May	98.66	81.46
July	98.36	81.00	June	98.60	80.86
August	98.70	81.60	July	98.36	80.46
September . .	98.40	81.36	August	98 76	81.56
October . . .	98.73	81.50	September . .	98.76	82.26
November . . .	98.60	80.60	October . . .	98.76	81.50
December . . .	98.63	77.96	November . . .	98.60	79.83
			Mean entire series	98.54	79.75

[1] Phil. Trans., part ii. 1850, p. 437.

[2] Ibid.

Table showing the Variable Temperature of Man. Drawn up from Observations on Seven Healthy Men, during a Voyage from England to Ceylon. By JOHN DAVY, M. D.

Age.	Temperature under tongue. March 10th. Temp. of air, 78°.	Temperature under tongue. March 2d. Temp. of air, 79.5°.	Temperature under tongue. April 4th. Temp. of air, 80°.	Temperature under tongue. May 5th. Temp. of air, 30°.
24	99.00°	100.00°	99.50°	98.50°
28	99.50	99.50	99.50	...
25	98.75	98.50	99.75	98.25
17	99.00	99.00	100.00	...
25	99.00	99.00	99.50	98.00
20	98.00	99.50	100.00	98.75
28	98.75	99.00	99.50	98.25

Table showing the Variations of the Temperature of different Races of Men. By JOHN DAVY, M. D.[1]

HOTTENTOTS. Cape of Good Hope, May 21, 1816. Tem. air, 60°.	SINGALESE. Island of Ceylon, Sept. 14th. Tem. of air, 79°.			ALBINOS (SINGALESE). Ceylon, Sept. 14th. Tem. of air, 79°.			HALF CASTE SINGALESE CHILDREN. Ceylon, Oct. 12th, 6–7 A. A. Temp. of air, 78°.				VAIDAS. Kandy, Sept. 12th. Temp. of air, 73°.				AFRICANS. Servants in military hospital at Kandy. Dec. 17th. Temp. of air, 74°.				MALAYS. Kandy, March 18th Temp. of air, 81°.				SEPOYS. Kandy, May 18th. Temp. of air, 80°.				ENGLISH SOL'RS. Kandy, May 20th. Tem. of air, 75°.		
Temperature under tongue.	Sex.	Age.	Temperature under tongue.	Sex.	Age.	Temperature under tongue.	Sex.	Age.	Temperature under tongue.	Temperature in axilla.	Sex.	Age.	Temperature under tongue.	Temperature in axilla.	Sex.	Age.	Temperature under tongue.	Temperature in axilla.	Sex.	Age.	Temperature under tongue.	Temperature in axilla.	Sex.	Age.	Temperature under tongue.	Temperature in axilla.	Sex.	Age.	Temperature under tongue.
°			°			°			°	°			°	°			°	°			°	°			°	°			°
98.0	F.	50	101.0	F.	5	101.5	F.	12	100.5	98.5	M.	60	98.0	95.0	M.	23	98.5	98.0	M.	17	98.5	98.5	M.	25	98.5	98.0	M.	21	98.75
96.5	F.	4	101.5	F.	12	101.5	F.	14	100.1	..	M.	30	98.0	96.0	..	35	98.5	98.0	M.	35	99.5	97.5	M.	19	99.0	96.0	M.	99	98.5
96.5	M.	29	101 0	F.	23	101.75	F.	17	100.0	..	M.	35	98.5	96.0	..	25	99.0	98.0	M.	22	99.0	98.0	M.	26	98.5	97.0	M.	27	99.0
97.75	M.	8	101.5	M.	27	101.0	M.	14	102.0	100.0	..	..	..	..	..	34	99.5	98.0	M.	18	98.5	97.5	M.	22	98.0	95.0	M.	36	99.25
99.5	M.	40	100.0	..	..	..	M.	10	101.5	99.5	..	..	..	..	..	28	99.5	98.0	..	..	..	..	M.	38	100.0	97.0	M.	28	99.0
..	M.	25	100.0	..	..	..	M.	14	100.0	99.0	..	..	..	..	..	..	..	..	..	..	..	..	M.	20	98.0	97.0	M.	34	99.5

[1] Researches, Physiological and Anatomical, vol. i. p. 169.

Table of Observations on the Temperature of the Insane in the Winter and Summer of 1838. By JOHN DAVY, M. D.[1]

Age.	Species of insanity.	Winter.		Summer.	
		State of health.	Temperature under tongue.	State of health.	Temperature under tongue.
55	Amentia	Pretty good	100.0°	Pretty good	101.0°
63	Mania	Good	100.0	Good	101.5
49	Mania	Good	100.0	Good	101.0
31	Amentia	Rather feeble	99.0	Feeble	101.0
41	Mania	Good	98.0	Good	101.0
42	Amentia	Good	99.0	Good	100.5
50	Amentia	Slightly ailing	102.0	Good	99.5
62	Amentia	Good	98.0	Good	100.5
69	Amentia	Feeble	100.0	Feeble	101.0
51	Amentia	Pretty good	99.0	Moderate	100.0
34	Amentia	Pretty good	100.0	Moderate	101.0
53	Amentia	Good	99.0	Good	101.0
37	Mania	Good	99.0	Good	100.0
41	Mania	......	101.0	Obscure disease of lungs	104.5
41	Amentia	Pretty good	99.0	Good	100.0
64	Mania	Good	101.0	Good	101.0
45	Amentia	Pretty good	100.5	Moderate	101.0
29	Amentia	Indifferent	99.0	Indifferent	99.0
57	Mania	Good	99.0	Good	100.0
61	Melancholia	Good	100.5	Good	101.0
40	Amentia	Good	100.0	Good	101.0
61	Amentia	Good	98.0	Good	100.0
47	Amentia	Good	101.0	Good	101.0
27	Amentia	Good	98.0	Good	100.0

Before proceeding to record the results of our investigations, it is necessary that I should state the methods by which the temperatures, pulse and respiration were determined, and the difficulties and imperfections of the investigation of the changes of the urine.

The pulse and respirations in the following investigations were, unless stated otherwise, always determined in the recumbent posture.

All the temperatures recorded were determined by the same instrument, which was carefully constructed, and was upon comparison with standard instruments found to be accurate.

The thermometer was always allowed to remain under the tongue, in the hand, or in the armpit, for some time after it was stationary, and all the observations were taken and recorded at the bedside, under my own hand and eye. The greatest care was exercised in determining the temperature; the patients were in all cases, unless stated otherwise, lying quietly in bed, and protected from all currents of air.

[1] Physiological and Anatomical Researches, vol. i. p. 204.

The importance of attending to these circumstances, is strikingly illustrated by the following experiments which I performed upon myself.

Athens, Jan. 23d, 6 o'cock A. M. Lying in bed, just after waking from sleep. Pulse, 76; respirations, 15. Temperature of air of chamber, 45° F.; temp. of exterior air, 28; temp. of hand, 95; temp. under tongue, 98. Dressed myself and took a walk of two miles over several hills, in thirty minutes. The ground was frozen and covered with frost. During the walk, my hands were bare and freely exposed to the atmosphere. At first, the sensation of cold was unpleasant, but towards the end of the walk, reaction appeared to take place, and they felt much warmer. Pulse, 90; respirations, 20. Temperature of atmosphere, 30° F.; temp. of hand, 78; temp. of axilla, 98.

During the walk, the pulse had gained 14, and the respiration 5, to the minute. The temperature in the hand had fallen 17°, whilst that in the axilla had remained stationary. The respiration in bed was gentle and regular. The respiration after walking in the cold was accelerated, full and vigorous. Here we see that a diminution of the temperature upon the exterior was attended by a corresponding change in the movements of the circulatory and respiratory systems. They became more active in order to receive and distribute more rapidly the oxygen, and remove with corresponding rapidity the increased products of the increased chemical changes.

It is also worthy of note that the increased circulation and respiration were not attended with a rise of temperature, because the radiation of heat from the surface of the body more than balanced the increased generation of heat consequent upon the increased chemical change.

I took breakfast, and then walked three miles over several hills, in forty minutes. My hands were kept in the overcoat pocket during the walk. At the end of the walk, the following were the results observed: Pulse, 88; respirations, 26. Temperature of atmosphere, 45° F.; temp. of hand, 97; temp. under tongue, 98.5.

January 24th, 4 o'clock P. M. After sitting and writing for several hours in a cold room, without fire, my right hand, which was freely exposed moving over the paper, felt very cold and stiff. Pulse, 76; respirations, 16. Temperature of atmosphere, 48°; temp. of right hand, 75; temp. in axilla, 98.5. In this experiment the right hand lost 22° in the course of two hours.

These experiments demonstrated conclusively the absolute neces-

sity of adhering rigidly to a uniform method of ascertaining the pulse, respiration and temperature in health and in disease.

In comparative investigations, the truth will not be obtained without the most scrupulous and unremitting attention to the position of the patient, and all the surrounding circumstances.

Before presenting the results of numerous analyses of the urine in the different forms of malarial fever, we would candidly acknowledge the sources of error in determining the amount of urine excreted during any stated period, as twenty-four hours.

When the bowels are frequently moved, it is almost impossible to ascertain, even approximately, the amount of urine excreted.

When the patient is delirious, and passes his urine and feces in the bed, it is impossible to ascertain either the amount or character of the urine. Even when the bowels are not moved, and the patient retains his faculties and a considerable amount of strength, it often happens that, during the night, the nurse will neglect to attend to the passage and preservation of the excretions in the proper vessels. It often happens, from a combination of these circumstances, that the urine of the most fatal, important and interesting cases, escapes our examination. These difficulties in hospital investigations cannot readily be overcome, and will often invalidate the conclusions drawn from individual cases.

Our duty, then, is to obtain as wide an induction of facts as possible, and thus eliminate or equalize, as far as possible, the errors, and draw our conclusions not so much from individual cases as from the whole assemblage of facts.

From our copious notes on more than two hundred cases of malarial fever, we have determined to present a condensed statement of only those facts which present points of interest to the physiologist, pathologist and practitioner of medicine, and will often refrain from noticing the full bearing of these facts, because our limits would not allow of extended discussions.

Our limits will not permit us to enter into a minute account of the method of analyzing the urine. In view of the numerous excellent treatises, accessible to all, this would involve an unnecessary consumption of space and time.

The urea[1] was separated in the form of the nitrate, and every

[1] Lehmann's Physiological Chemistry, Eng. ed., vol. i. p. 159; Am. ed., vol. i. p. 149. Mitscherlich in Annalen der Physik und Chemie, Von Poggendorff, bd. 31, s. 303. "Kidneys and Urine," by J. J. Berzelius, translated by Boyle and Leaming, M. D. Phila., 1843, pp. 66–83. "Handbook of Chemistry," by Leopold Gmelin,

care was taken to secure accuracy in the results. The amount of the constituents in all these analyses, from the causes previously stated, will be underrated and never overrated.

The urine was always analyzed a short time after its passage. This precaution is necessary in a warm moist climate like that of Savannah. In the heat of summer, the urea is often, especially in the urine of convalescence, rapidly decomposed into carbonate of ammonia. In one case of malarial fever, where the patient was suffering with a stricture and irritation of the bladder, every trace of urea disappeared from the urine in twelve hours.

I have endeavored scrupulously to exclude from these papers

translated by H. Watts, Cav. Soc. pub. London, 1852, vol. vii. p. 363. Simon's Chemistry of Man. Phila., 1846, p. 397. Becquerel and Rodier's Pathological Chemistry, translated by Speer. London, 1857. See also for the general analysis of the urine, "Anleitung zur qualitätiven und quantitätiven Zoochemischen Analyse." Von E. Von Gorup Besanez. Nürnberg, 1854. "Anleitung zur qualitätiven und quantitätiven Analyse des Harns." Von Carl Neubauer. Wiesbaden, 1854. Heintz, Lehrbuch der Zoochemie. Berlin, 1853. Schlossberger, Lehrbuch der organischen Chemie, mit besonderer Rücksicht auf Physiologie und Pathologie. Stuttgart, 1854. Robin et Verdeil, Traité de Chimie Anatomique et Physiologique, ou des Principes immediats Normaux et Morbides que Constituent le Corps de l'Homme et de Mammiferes, 3 vols. Paris, 1853. "A Course of Practical Chemistry," arranged for the use of Medical students, by Wm. Ordling, M. D. London, 1859. "Bird on Urinary Deposit." Phila., 1854. Bowman's Medical Chemistry. Phila., 1855.

For Liebig's valuable Memoir "On Certain Urea Compounds, and a new method of determining the Chloride of Sodium and the Urea in the Urine," see Ann. der Chem. und Pharm., vol. lxxxv., pp. 289–328. See translation of this Memoir in vol. vi. of the Quarterly Journal of the Chemical Society. Limpricht, "On the Influence of Allantoin on the determination of Urea, by the method of Liebig," Ann. der Chem. und Pharm., vol. lxxxvii. p. 99. Kletzinsky, "On the Comparison of the Values of the Different Methods of Determining the Quantity of Urea," Heller's Archiv. für Chem. und Mikrosk., p. 252. Jahrgang, 1853.

"A new Method of Determining the Amount of Urea," by Dr. E. Davy. Phila. Mag., June, 1854; Medico-Chir. Rev., Oct., 1854. "The Detection and Estimation of Urea," by Ragsky, Ranking's Abstract of Med. Sciences, 1845. Part ii. p. 90. Beiträge zur Kenntniss der Urinabsonderung bei gesunden, schwangern und kranken Personen. Inaugural Abhandlung von Friedr. Mosler. Giessen, 1853. Klinische Untersuchungen über den Stoffwechsel bei gesunden und kranken Menschen überhaupt, und durch den Urin insbesondere. Von Prof. J. Vogel. Göttingen, 1853. "Studien zur Uroligie." Von Dr. F. Fr. Bencke (Archiv. des Vereins für gemeinschäftliche Arbeiten, Band i., Hefte 3, 4). Göttingen, 1853.

Beiträge Zu Kenntniss der Urinabsonderung bei gesunden Inaugural Abhandlung von Aug. Winter. Geissen, 1852.

"A Treatise on the Pathology of the Urine," by I. L. W. Thudichum, M. D. London, 1858.

Beale's Archives of Medicine, No. 1, pp. 34–42; No. 2, pp. 142–147.

every analysis, the result of which was influenced by changes in the urine, subsequent to its excretion by the kidneys. Uric acid was determined in the usual manner. The inorganic fixed saline matters were determined according to the method of M. Lecanu.

I. INTERMITTENT FEVER.

Cold Stage.

Proposition I. *During the cold stage (chill) there is a rapid, feeble pulse, full, rapid respiration, and a hot trunk and cold extremities.*

During the rapid thoracic respiration oxygen is supplied in abundance, and enters into the blood, which is confined during the cold stage almost entirely to the trunk and large organs. The amount of oxygen received, and the elevation of the temperature of the trunk, will depend upon the capillary circulation of the lungs and large organs of the trunk, and upon the action of the heart.

Proposition II. *During the cold stage the temperature of the extremities is reduced far below that of the trunk, and even below the standard of health, because the circulation of the blood in the bloodvessels and capillaries is feeble.*

The surface of the trunk and extremities presents a mottled purplish color during the cold stage, because, the supply of oxygen being greatly diminished, the change from the venous to the arterial hue does not take place.

The shivering and twitching of the muscles during the chill are excited in a manner analogous to the shivering produced by exposure to cold. When the temperature of the extremities is rapidly reduced by rapid radiation, the capillary circulation becomes feeble, the surface presents a wrinkled and often bluish appearance, the blood is not furnished in sufficient quantities to supply the elements of nutrition and chemical change in the muscles and nerves, the chemical actions of both the muscles and nerves are diminished and perverted, and, as a necessary consequence, this diminution and perversion of chemical change is attended by aberrated muscular and nervous action.

The phenomena of diminished capillary circulation, and corresponding diminution in the supply of nutritive materials, and elements of chemical change, and reduction of temperature, may be

also produced by derangement of the general circulation and derangements of the sympathetic nervous system. In both cases the cause of the diminished temperature in the extremities would be due to feeble capillary circulation. In both cases the cause of the aberrated muscular and nervous phenomena would be due to diminished and perverted chemical changes.

That the chemical changes are perverted during this state of reduction of animal temperature and diminution of capillary circulation is conclusively demonstrated by the fact that in congestive fever, where we have, as it were, a permanent reduction of temperature, and arrest of capillary circulation, and diminution of chemical change, both in the trunk and in the extremities, the products resulting from these perverted chemical changes are far different both from those of health and those of fever, when the system reacts.

Proposition III. *The diminution of the capillary circulation and reduction of the temperature of the extremities precede the aberrated nervous and muscular phenomena denominated chill.*

This fact corresponds to the changes in the blood, and demonstrates conclusively that *the first phenomena of the cold stage are connected with the sympathetic nervous system.*

Proposition IV. *The higher the temperature of the trunk during the cold stage, the more rapid will be the equalization of the circulation and temperature.*

These propositions are sustained by the following cases:—

(*a.*) Seaman, aged 55; height 5 feet 4 inches; small, spare man. Has been in the hospital several months, suffering with an affection of the eyes. This case of intermittent fever originated in the hospital.

Chill came on one hour ago; he is still shaking violently, and his lips and hands look blue. Pulse 100, feeble, small. Respiration 36 to 50, varies with each quarter of a minute; irregular, thoracic, labored. Temperature of atmosphere, 71.5° F.; temp. of hand, 92°; temp. under tongue, 104°.

(*b.*) Seaman, aged 38; height 5 feet 8 inches; light hair, blue eyes, sallow complexion; looks as if his liver was out of order. Says that he has had chills off and on from the 16th of July to the present time, October 12. His first attack of intermittent fever was

contracted in the swamps of the Peedee River, South Carolina. Tongue clean and pale; lips pale, anæmic. This patient presents the true malarial hue, and his blood is deficient in colored corpuscles. In the present attack of intermittent fever he has a chill every day.

October 12. This morning had a chill, followed by hot fever. During the febrile excitement his pulse was 108 and his respiration 32 to the minute. As soon as the fever remitted, twenty grains of sulphate of quinia were administered. The sulphate of quinia delayed the chill. It did not appear at the regular hour on the 13th inst., but came on at 4 o'clock P. M. on the 14th inst. At this time I commenced the examination about fifteen minutes after the commencement of the chill.

Lips and fingers pale, and of a bluish color; extremities cold, whilst the trunk is hot to the touch. Patient is shaking all over. Pulse 92, feeble; respiration 32, full and labored. Temperature of atmosphere, 77.5° F.; temp. of hand, 91°; temp. under tongue, 103°.

A small amount of urine was excreted at the close of the cold stage and commencement of the general elevation of temperature (equalization of the actions of the general and capillary circulation), which had a normal color. Specific gravity, 1023. Reaction decidedly acid. One thousand parts contained—urea 21.825, uric acid 1.467, fixed saline constituents 7.436.

During the sweating stage, the reaction of his skin was neutral; as a general rule, I have found it to be acid in the various forms of malarial fever. Reaction of saliva, as usual, acid.

October 15, 1859. Complete intermission of fever. Pulse 80, fuller; respiration 20, regular. Temperature of atmosphere, 71.5° F.; temp. of hand, 96°; temp. under tongue, 98°.

(*c*.) Frenchman, aged 45; brown hair and eyes; height 5 feet 7 inches; weight 130 pounds. Thin, spare man. Had an attack of intermittent fever, commencing September 15.

This case was treated in the Savannah Poor-house, and yielded to the ordinary remedies, and the patient was discharged in the course of ten days. He returned to a miasmatic situation, and was again attacked with intermittent fever.

Entered the hospital and poor-house October 7, and stated that for the last four days he had had "dumb ague," which came on every day at the same hour (11 o'clock A. M.), and lasted two hours. A purgative, followed by twenty-five grains of sulphate of

quinia, was administered. This delayed the "dumb ague" until October 9, 3½ o'clock P. M. (twenty-eight hours).

Examination commenced half an hour after the commencement of the "dumb ague." Lips and fingers purplish; extremities cold; head and trunk warm. Complains greatly of the sensation of cold, but shakes far less than in the former cases recorded. Pulse 92, so feeble that it is with difficulty felt, and with still greater difficulty counted. The vibrations of the pulse resemble those of a fine thread. Respiration accelerated and irregular. Temperature of atmosphere, 75° F.; temp. of hand, 83; temp. under tongue, 101.5.

6½ o'clock P. M. Reaction has taken place, and he now has fever. Pulse 96, much fuller than during the chill, but weaker than in a frank open case. Temperature of atmosphere, 70° F.; temp. of hand, 101.75; temp. under tongue, 102.75. In this case, which was far more serious than the preceding cases, we observe that the temperature of the trunk was not so much elevated during the chill, nor during the subsequent reaction.

The urine indicated serious disturbances; it was of a high color and specific gravity, and correspondingly rich in urea and extractive matters. The uric acid was slightly increased.

Oct. 10th. Intermission of fever. Temperature of atmosphere, 70° F.; temp. of hand, 97.5; temp. under tongue, 98.5.

(*d.*) Irishman; black hair; black eyes; height 5 feet 10 inches; weight 130 lbs. In health florid complexion. Has been suffering with intermittent fever for four days; chills have been slight. The present chill (Sept. 23d, 1857) is slight. Temperature of atmosphere, 79° F.; temp. of hand, 90; temp. under tongue, 102.

(*e.*) *Seaman:* Englishman; brown hair; brown eyes; florid complexion in health, now his complexion is anæmic; weight 146 lbs.; age 25; height 5 feet 6 inches. Sept. 10th. Entered the Savannah Marine Hospital, with bilious remittent fever, and from this date until the 19th inst. was extremely ill. This patient recovered so as to be able to walk about the hospital yard. Notwithstanding the administration of tonics and iron, his complexion was pale, anæmic, and he complained of a severe and continued pain in his head.

On the 4th of October, he was taken with severe chill, followed by high fever. This returned every day.

Oct. 6th. The chill has been on him one hour, and the hot stage is just coming on. Pulse 110, feebler than after the complete reaction, but stronger than during the lowest depression of the cold

stage. Respirations irregular, thoracic, panting, from 40 to 50. Muscles trembling violently. Temperature of atmosphere, 70°F.; temp. of hand, 97; temp. under tongue, 104.

(*f*.) Irish laborer; stout, well formed man; sanguine temperament; light hair; blue eyes; florid complexion; height 5 feet 9 inches; weight 190 lbs. This is his second attack of chill and fever this season.

Sept. 18th, 11 A. M. Chill is now just going off. Pulse, 112; respiration, 28. Temperature of atmosphere, 90.5° F.; temp. of hand, 100; temp. under tongue, 104.

19th, 2 P. M. Apyrexia complete. Pulse, 68; respiration, 24. Temperature of atmosphere, 91° F.; temp. of hand, 97.5; temp. under tongue, 99.

Recovered from this attack. Commenced work upon a steam-tug, and slept on board in the Savannah River, at night. Returned to the hospital with a third attack of intermittent fever.

Oct. 2d, 2 P. M. Has a chill, and is shaking violently. Pulse 120, in sitting posture. Respiration 22, in sitting posture. Temperature of atmosphere, 79° F.; temp. of hand, 89; temp. under tongue, 102.25.

3d, 2 P. M. Has high fever. Pulse, 100; respirations 26, full. Temperature of atmosphere, 77.5° F.; temp. of hand, 105; temp. under tongue, 106.

Oct. 4th, 2 P. M. Apyrexia complete. Pulse, 58; respiration, 20. Temperature of atmosphere, 76° F.; temp. of hand, 96.5; temp. under tongue, 98.5.

(*g*.) *Seaman:* Age 22; height 5 feet 4 inches; weight 140 lbs.; black hair and florid complexion; sanguine, nervous temperament; native of New York.

Sept. 29th, 1857. Entered the Savannah Marine Hospital, with intermittent fever. Has never been sick before in his life. Has been in Savannah two weeks, and this is his first visit. Says that he was taken sick, four days ago, with chill, vomiting, and pains in all his bones, and has had a chill every day since, commencing regularly at 12 o'clock M. Had a chill this day, commencing a few minutes after 12 o'clock M. Says that he took three blue pills and castor oil, night before last. This medicine operated twice.

7 o'clock P. M. Has fever, and complains of pains in his joints. Slight tenderness upon pressure of epigastrium. Tongue clean, moist, red at tip and edges; papillæ enlarged and of a bright red color. Reaction of saliva decidedly acid. Pulse, 120; respiration

32, full, thoracic. Temperature of atmosphere, 79° F.; temp. of hand, 103.33; temp. under tongue, 106.

℞.—Calomel gr. xij; sulphate of quinia gr. vij. Mix and administer immediately, and follow with castor oil in four hours. As soon as fever remits, give sulphate of quinia gr. v, every three hours, up to gr. xxv. During fever, give soda powders (pulveres effervescentes tartarizati). Diet, gruel and flaxseed tea.

30th, 1 o'clock P. M. Medicine operated freely, and says that he is much better, but complains of weakness. Tongue presents the same appearance; skin cool and relaxed; face not so much flushed. Pulse 70, regular; respiration 22, regular and gentle. Temperature of atmosphere, 68° F.; temp. of hand, 92; temp. under tongue, 99.5. Here we see, that although the pulse and respiration are more rapid than in health, the temperature of the trunk is normal, whilst the temperature of the extremities is 6° below the normal standard, and there is no shaking of the muscles.

Color of the urine, light orange, sp. gr. 1009. Reaction decidedly acid. Uric acid in grs. 23,220 of urine passed during the last 18 hours, gr. 1.0035. Uric acid in grs. 30,952 of urine calculated for 24 hours, gr. 1.3376. Up to this time, 1 o'clock P. M., has taken 20 grs. of the sulphate of quinia, and the marked diminution of the uric acid may be connected with the action of this medicine.

5 o'clock P. M. Half an hour ago was taken with chill and vomiting. Now the chill appears to be subsiding, the shaking and contraction of the muscles are diminishing. Extremities cool, whilst the head and trunk are pungent to the hand. Pulse 108, feeble, respiration 30, full, labored, panting. Temperature of atmosphere, 74° F.; temp. of hand, 91; temp. under tongue, 105.5. In three hours and a half the pulse has increased 38 beats in the minute; the respirations have increased 8 in the minute; the temperature of the extremities has diminished, whilst that of the trunk has increased 6°. *The comparison of this observation with the preceding one three hours ago, demonstrates the truth of the 3d proposition, viz: the diminution of the capillary circulation, and reduction of the temperature of the extremities, precedes the aberrated nervous and muscular phenomena, denominated chill.*

8½ o'clock P. M. Three hours and a half after the observation upon the chill, the relations between the temperature of the trunk and extremities have been restored, and the shaking and shivering of the muscles, and the sensation of cold, have vanished. Pulse 108, fuller and stronger; respiration 32, not so full and labored as

during the chill, but still much fuller and more labored than during health. Temperature of atmosphere, 73° F.; temp. of hand, 103.5; temp. under the tongue, 105.

Specific gravity of urine excreted during the cold stage and commencement of the hot stage, 1020. Color normal. Reaction decidedly acid. Uric acid in 5100 grs. of urine excreted during 8 hours, grs. 2. Uric acid in 15,300 grs. of urine calculated for 24 hours, grs. 6. The uric acid has increased in amount during the chill and commencement of the fever, when compared with the former specimens of urine; it is, however, still below the standard of health. If the diminution of the amount of uric acid be due to the action of the sulphate of quinia, it shows that this action of this remedy pointed out by Ranke,[1] is not necessarily attended by a disappearance of the chill.

Oct. 1st, 11 o'clock A. M. Apyrexia; says he is better and has no pain except a slight headache, and was in a perspiration all night. Fever intermittent at 12 P. M. Skin cool. Pulse, 76; respiration, 23. Temperature of atmosphere, 70° F.; temp. of hand, 95; temp. under tongue, 98.5. Has taken 15 grs. of sulphate of quinia since the intermission of the fever.

(*h*.) Englishman, entered the Savannah Marine Hospital, Oct. 9th, 1857; age 27. Has been in America thirteen years. Height 5 feet 10 inches; weight 145 lbs.; muscular system well developed; sanguine temperament; occupation, steward on ship; has been in Savannah three weeks. Says that he was taken yesterday at 12 o'clock M. with cold feelings and headache. The chilly feelings lasted four hours, and were succeeded by fever, which continued until 4 o'clock this morning. Two and a half hours after the subsidence of the fever (8½ o'clock A. M.) he shook violently. This chill was followed by fever.

Now, 8 o'clock P. M., fever is subsiding. Pulse 98, full but soft. Temperature of atmosphere, 72° F.; temp. of hand, 102.5; temp. under the tongue, 103. Tongue moist; skin in a profuse perspiration; says that he took last evening a dose of salts and cream of tartar, which operated twice this morning. ℞.—When fever goes off, give sulphate of quinia, grs. v, every three hours up to grs. xx.

Oct. 10th, 12 o'clock M. There was a complete intermission of the fever about 2 o'clock this morning. At this time the sulphate of quinia was commenced, and he has taken gr. xv.

[1] Medical Times and Gazette, May 30, 1857, p. 540.

Amount of urine passed during the last 16 hours . . 6144 grs.
" " hourly " " . . 321.5 "
Calculated amount of urine for 24 hours . . . 9216 "

	In 6144 grains of urine (16 hours).	In 9216 grains of urine calculated for 24 hours.	In 1000 parts of urine.
Urea	226.980 grs.	340.470 grs.	36.943
Uric acid	0.600 "	0.900 "	0.097
Fixed saline constituents .	40.200 "	60.100 "	6.542

Sp. gr. of urine 1024—clear; no deposit; light red color. Reaction decidedly acid. After standing 12 hours no deposit; after standing 36 hours, a very slight light-yellow deposit; after standing 60 hours the surface was covered with a pellicle, which, under a magnifying power of 210 diameters, was found to consist of small oval cells, about the size of human blood-corpuscles. There were also other elongated elliptical cells, the short diameters of which did not differ from those of the globular cells. Many of the elongated cells had a vibratory motion. The deposit at the bottom consisted of these globular elliptical acicular cells, and a few crystals of triple phosphate. That these cells were organized bodies was demonstrated by the action of chemical reagents under the microscope. Not a trace of uric acid was found in the pellicle and deposit.

$12\frac{1}{2}$ *o'clock P. M. A chill is just coming on. The thermometer placed in his hand, indicated* 91.5° *F. Simultaneously with the increase in the sensations of cold, it commenced to descend, and in fifteen minutes stood at* 87.5°, $10\frac{1}{2}$ *degrees below the normal standard. In fifteen minutes his hand lost* 4°, *and simultaneous with this loss of temperature in the extremities, the sensation of cold increased. He feels very cold, but does not shake. The extremities feel cold, whilst the surface of the head and trunk feels hot and pungent. When the bulb of the thermometer was simply placed between the skin and flannel shirt, and gently pressed against the surface of the chest, it commenced to rise rapidly, and in a few moments indicated* 103° *F., and when placed in the armpit, it rose rapidly to* 107° *F. Pulse* 100, *not so full as during fever, but small, feeble, and threaded. Respirations* 26, *full and labored. Temperature of atmosphere,* 68.5° *F.; temp. of hand,* 87.5°*; temp. of axilla,* 107°. *Tongue pointed, but moist, and not much redder than usual. Skin dry, with a purplish mottled appearance as if the circulation in the capillaries was retarded. Says that he has dull "wandering pains around his loins up to his chest." Complains of great thirst. His stomach is so irritable that I could not ascertain the temperature under his*

tongue. I made seven unsuccessful attempts. At every trial the contact of the bulb of the thermometer with the base of the tongue excited violent retching and vomiting. I applied a sinapism over the region of the spinal column, eighteen inches in length, and three inches in breadth, also one over the epigastrium, and administered stimulants. In half an hour after their application, the mustards and stimulants assisted in arousing the capillary circulation in the extremities. His surface does not present the mottled appearance; the heat has, in a great measure, returned to his extremities; the cold sensations have disappeared, and he "feels warm all over." The temperature of his hand is now 99°, *whilst the temperature in the axilla is still* 107°. *In half an hour the temperature of the extremities has risen* 11.5°. *The temperature of the hand does not correspond fully with that of the trunk, and reaction is not yet fully established.*

Has just passed clear limpid straw-colored urine. Sp. gr. 1003. Amount of urine voided, 7021 grs.

	7021 grains of urine contained.	1000 parts of urine contained.
	Grains.	
Urea	39.551	5.650
Uric acid	0.420	0.059
Fixed saline constituents . . .	9.800	1.395

Nitrate of urea remarkably silky and white.

Microscopical Examination.—The urine was placed in a closely stoppered bottle, and set aside for sixty hours. At the end of this time there was a pellicle over the surface, and a small light-yellow deposit. The pellicle consisted entirely of the globular, elliptical, and vibrating cells, observed in the former specimen. The deposit also consisted of these cells, and a few beautifully formed, prismatic crystals of triple phosphate. This specimen of urine was interesting, because it was passed at the close of a chill, and was probably excreted by the kidneys during the existence of the cold stage. It was much lighter in color than that passed during fever; in fact it resembled the urine of hysterical women, in its light color and low specific gravity.

Phenomena during the Hot Stage and Period of Intermission.

Proposition V. *The higher the temperature of the trunk during the cold stage, and of the extremities and trunk during the subsequent hot stage (stage of equalization of the circulation and chemical action), the*

milder and shorter will be the attack, as a general rule, provided there be no complication, as congestion of the brain.

Whenever, as in congestive fever, there is a want of correspondence between the circulation, respiration and chemical changes, the patient is always in danger. A patient with a rapid feeble pulse, and rapid thoracic respiration and low temperature (sluggish chemical changes), is always in great danger. In cases of malignant (congestive) malarial fever there is, as far as my observations extend, a want of co-ordination between the actions of the circulatory and respiratory systems, and the rapidity and character of the chemical changes. The heart attempts to propel the blood; it beats rapidly (flutters 140 to 160 times in the minute), but the blood does not flow readily through the capillaries, because the chemical changes are in a great measure arrested, and in many cases perverted. On the other hand, the bounding, full, accelerated pulse; the full, heaving, accelerated respiration, and correspondingly high temperature, are always favorable symptoms, provided there be no complication, as obstinate vomiting, or cerebral symptoms. *The severity of the fever is by no means proportional to the height of the fever (animal temperature), for, as a general rule, the higher the fever (temperature), the more readily does the attack yield to treatment, and the less serious the effects.*

A high temperature, then, in intermittent fever, is a favorable symptom.

Whether the high temperature signifies an effort on the part of nature to break up, chemically alter, destroy, and throw off, the malarial poison; or whether the high temperature be significant of nothing more than vigorous, vital, nervous, physical, and chemical forces; nevertheless the determination of the correlation of the respiration, circulation, and temperature, affords the most valuable information to the medical practitioner.

PROPOSITION VI. *In malarial fever there is a close relation between the state of the skin, pulse, respiration, and temperature of the extremities and trunk.*

A rapid, full pulse, hurried, full respiration, and dry skin, were attended with a corresponding elevation of temperature. If the functions of the organs and apparatus be properly performed, a full, and rapid, vigorous circulation and respiration, must be attended by the rapid absorption of oxygen, and exhalation of car-

bonic acid gas, and correspondingly rapid chemical changes, and development of heat.

A slow pulse, and respiration, and moist skin, was always accompanied with a reduction of temperature.

During the intermission of the fever, the slow pulse, and respiration, and moist, relaxed skin, were attended with a reduction of the temperature, in many cases, below the standard of health.

The questions immediately arise: Is the intermission of the fever due to the restoration of the functions of the sudoriparous glands, which collectively expose a surface of tubing 1,570,000 inches, or nearly 28 miles in length? Is the morbific agent or agents, which have disturbed the chemical actions and correlation of the forces, eliminated by these glands?

If the intermission is due to the restoration of the functions of the sudoriparous glands, what excited them to action?

Is the phenomena connected with the nervous system alone, or with chemical and physical changes of the morbific agents, and of the blood, and secretions, and excretions?

If the reduction of temperature be not dependent upon the restoration of the functions of the sudoriparous glands, what retarded the chemical actions by which the physical forces are generated?

If the chemical actions developing an unusual amount of heat were excited by the introduction of foreign elements, may not the foreign elements themselves have entered into these chemical actions, and been so altered that they have been for a time rendered inert?

That a special end is accomplished in malarial fever by an elevation of temperature, is proved by the fact that the cases which manifest the highest temperatures, are, as a general rule, attended with little or no danger; whilst in those cases, as congestive fever, where there is a depression of temperature, the danger is always imminent.

It is true that the sudoriparous glands have much to do with the regulation of the temperature, for the water which they eliminate from the blood during its evaporation, abstracts one thousand degrees of heat from the surface of the body and the surrounding atmosphere. The heat is expended in the mechanical action of keeping asunder the particles of water, and is hence insensible to the thermometer. The experiments of Dr. Southwood Smith,[1] at

[1] Philosophy of Health, vol. ii. pp. 391–396.

the Phœnix Gas Works, and of MM. Berger, Delaroche,[1] Fordyce, Blagden,[2] and others,[3] have shown that when animals and man were subjected to great external degrees of heat, the temperature of the body was regulated by the evaporation from the surface of the skin and lungs. When the air was dry, individuals were able to endure, for a considerable length of time, a temperature of from 250 to 350 degrees, without injurious effects, and without any great elevation of temperature. The loss of water from the surface of the body was correspondingly great, and by its evaporation maintained the temperature of the interior at the normal standard. If, however, this evaporation be interfered with, by saturating the air with aqueous vapor, the temperature rose rapidly, and the individuals died in a short time.

The determination of the fact that the sudoriparous glands can, to a certain extent, regulate the temperature of the surface, does not by any means prove that the remission or intermission of malarial fever is due to the restoration of the function of these glands. In congestive fever, when these glands are active, and the whole surface is bathed in perspiration, the malarial poison is far more active than in remittent and intermittent fevers, attended with a rapid, bounding pulse, and rapid, full respiration, and high temperature, and hot, dry skin.

[1] Expériences sur les Effets qu'une forte Chaleur produit sur l'Economie, Paris, 1805; and Journal de Physique, tomes lxxi. et lxxiii.

[2] Philosophical Transactions, 1775.

[3] "Magendie's Experiments upon the Influence of Hot Air on Animal Life;" Am. Journ. Med. Sciences, Jan., 1845, p. 183. M. Constantine James, "On the Effects of the Hot Moist Air of the Baths or Stoves of Nero, at Pozzuoli;" Gazette Médicale, 27th Avril, 1844. W. F. Edwards, "On Animal Heat;" Cyclopædia of Anatomy and Physiology, vol. ii. pp. 649–684. John Davy, "On Animal Temperature," Phil. Trans., 1814; Edinburgh Philosophical Journal, Jan., 1826; see also Researches, Physiological and Anatomical, by John Davy, London, 1839, vol. i. pp. 141–248. Experiments of Tillet and Duhamel, "Experiments on the Servants of a Baker, at Rochefoucault, in Angoumois;" Mém. Acad. Scien., pour 1764, p. 186 *et seq.* Experiments of Dobson at Liverpool; Phil. Trans. for 1775, p. 463 *et seq.* "Observations on the Effects of High Temperatures," by Bell, of Manchester; Manchester Memoirs, vol. i. p. 1 *et seq.* Currie "On the Application of Water at Different Temperatures;" Phil. Trans. for 1792, p. 199 *et seq.* Experiments of Delaroche, Journ. Phys., t. lxiii. p. 207. Nicholson's Journ., vol. xvii. p. 142, 215. Journ. Phys., t. lxxi. p. 289, and t. lxxvii. p. 1. Lavoisier on Transpiration, Mém. Acad. pour 1790. John Reid on Respiration, Cyclopæd. of Anatomy and Physiology, vol. iv. pp. 325–368.

Appearances of the Tongue in Intermittent Fever.

In almost every case the papillæ of the tongue were enlarged, and of a bright, red color. In the mildest cases the tongue was only slightly coated with white and light yellow fur, and the tip and edges were redder than normal. In the severest cases the tip and edges of the tongue assumed a bright-red color, and the tongue was much dryer than in the milder cases, and the reaction of the saliva more intensely acid. The fur of the tongue in many cases was thick, and of a brownish-yellow color. The reaction of the saliva was always acid during the active stages, and the intensity of the acid seemed to correspond, in a measure, to the severity of the disease.

Characters of the Urine in Intermittent Fever.

In the mildest cases the characters of the urine did not differ very essentially from those of health.

As a general rule the amount of urine excreted during the active stages, and during the earliest period of intermission, when the temperature of the trunk and extremities sinks below the normal standard, was less than that of health. During convalescence, especially under the action of depurants, the amount of urine excreted was greatly increased.

These statements cannot be applied rigidly to all cases, for the urine is affected by so many varied external and internal conditions, that the amount excreted exhibits great fluctuations, even in health. No two observers agree with reference to the amount excreted in definite periods.

Thus, Lecanu, from the examinations of the urine of sixteen individuals, living upon mixed food, estimated that the amount of urine discharged in twenty-four hours ranged from 8085 grains to 34,973 grains.

Becquerel found that the mean daily quantity passed by four men was 19,511 grains, and that by four women was 21,130 grains. Lehmann, from experiments instituted upon himself, estimated the quantity discharged daily at from 13,829 grains to 22,299 grains.

According to the valuable experiments of Dr. William A. Hammond, instituted upon himself, the amount of urine excreted under a mixed diet ranged from 19,684 grains to 22,756 grains, with a

mean of 20,898 grains; under a diet of albumen, from 12,325 to 21,592, with a mean of 17,738; under a diet of starch, from 14,339 to 23,352, with a mean of 18,427 grains; and under a diet of gum, from 20,516 to 23,721 grains, with a mean of 21,538 grains.

The only accurate method of determining whether or not the urine be increased or diminished is to refer it to the standard of health in the individual examined. In hospital practice this is in the majority of cases impossible, and we are compelled to be content with approximate results.

The density of the urine was slightly increased in the majority of cases during the active stages, and in others it remained at the standard of health, and in others, again, it varied within wide limits.

The color of the urine varied from deep yellow and the normal yellow color to light red. During the active stages deep orange was the most common color.

The intensity of the color was greatest during the active stages, and diminished during convalescence.

During the active stages of intermittent fever the urine always *contains more* FREE ACID than in health. It will retain the acid reaction for several days, even in the heat of summer.

When the fever intermits, and the skin is soft and relaxed, and the patient is convalescent, the urine then excreted rapidly undergoes decomposition, and in a few hours the reaction changes from acid to alkaline. I believe this to be one of the most certain signs of convalescence in malarial fever. The acidity of the urine in malarial fever is in proportion to the severity of the attack; it is more intense in remittent that in intermittent fever, and still more intense in congestive fever than in intermittent and remittent fever.

The urea was increased during the active stages above the standard of starvation. During the active stages the patients took little or no nourishment, and the urine excreted during these periods should be compared with that excreted during starvation and repose, and not with that of health. Unfortunately the standard of the urine during starvation varies with each individual, and as it is impossible to establish a standard previous to the attack in the great majority of hospital patients, we can only establish approximate results.

In the majority of the cases the URIC ACID *was diminished*, both with and without the action of the sulphate of quinia, during the active stages, when the pulse was full and rapid, and the respira-

tion full and accelerated, and the temperature elevated. In almost every case, as the fever declined, the uric acid increased above the standard of health, both with and without the action of the sulphate of quinia.

From the microscopical examination of several hundred specimens of urine excreted during the different forms of malarial fever, I found it, as a general rule, to be true that, in the mode of treatment which I adopted, the uric acid appears in much larger quantities in the urine of convalescence than in that excreted during fever, even when the sulphate of quinia had been withheld, or sparingly administered.

The majority of specimens of urine excreted during fever, which were set aside and examined under the microscope, at successive intervals, gave no deposits of the crystals or salts of uric acid, whilst specimens of the urine of convalescence very soon gave evidence of the presence of uric acid, by letting fall deposits of urate of soda and ammonia.

As far as my observations extend, it may be stated, as a general rule, that the PHOSPHATES *are more abundant* in the stage of convalescence than during the active stages.

The deposits so common during convalescence consist chiefly of urates of soda and ammonia, and the phosphates most generally in the form of the triple phosphate.

The chief reason why the deposit of the phosphates is more frequent in the intermission than in the active stages is because the urine in the active stage of convalescence is far less acid, and far more readily decomposed and rendered alkaline by the ammonia resulting from the decomposition of the urea, than the urine of fever.

These facts explain the nature of the so-called *critical discharges* of malarial fever. The urine excreted during fever is generally deficient in uric acid and the earthy salts, whilst its acidity and power of resisting decomposition is greatly increased, and it will remain for a great length of time without undergoing decomposition. The urine of convalescence, on the other hand, is rich in uric acid and the earthy and alkaline salts, and readily undergoes decomposition. The deposit of the urates of soda and ammonia, and the precipitation of the triple phosphate by the ammonia generated during decomposition of the urea, form the so-called critical discharges. As a general rule, the urine excreted during the hot stage of intermittent fever is poorer in uric acid than the urine of

remittent fever; and I have known cases in which, during fever, the uric acid disappeared almost entirely. In several cases of congestive fever the urine contained only traces of uric acid, and in one case, which terminated fatally, the disappearance of the uric acid was attended with the disappearance of the urea. Dr. Ranke[1] states, in his article upon the physiological action of sulphate of quinia, that, according to all observers, there is in ague an increase of uric acid. My observations do not correspond with this assertion, if it is intended to apply to the active stages of intermittent, remittent, and congestive fevers. The fact that uric acid increases during convalescence from malarial fever demonstrates conclusively that the diminution of the amount of uric acid by sulphate of quinia is an attending circumstance, and not necessarily one of the beneficial remedial modes of the action of this medicine.

As a general rule, the EXTRACTIVE AND COLORING MATTERS *are less abundant* during the active stage of intermittent fever than during the first period of the intermission. They are either not formed in such abundance, or if formed, are partially consumed during the active chemical changes of fever.

The nitrate of urea formed from the urine excreted during the active stages of intermittent fever is silvery white, whilst the nitrate of urea formed from the urine excreted during the intermission is dark, discolored, and the crystals are not so well formed. The former kind of urine, when evaporated and concentrated, generally has a yellowish or brownish color, whilst the concentrated urine of the intermission assumes the color of a very strong decoction of over-parched coffee. The depressed state of the forces consequent upon the continued action of the malarial poison is, as far as my observations extend, attended by a marked diminution of the solid constituents of the urine.

These propositions and statements will be illustrated by the following cases:—

[1] Medical Times and Gazette, May 30, 1858, p. 537.

TABLE I.

Observation.—(*h.*) Seaman; native of New York; age 22; height 5 feet 4 inches; weight 140 lbs.; black hair, florid complexion; handsome, intelligent countenance; sanguine nervous temperament. Has never been sick before; has been in Savannah two weeks, and this is his first visit; has slept on board the ship lying in the Savannah River. Was taken sick four days ago, and has had a chill every day since at 12 o'clock M.; had a chill this day commencing a few minutes after 12 o'clock M. Says that he took three blue pills and castor oil night before last; this medicine operated twice.

Date.	Hour of day.	Medicine.	State of Skin.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Urine excreted in 24 hours.	Uric acid excreted in 24 hours.	Urine excreted hourly.	Urine excreted in	Hours.	Specific gravity.	Uric acid.	Calculated amount of urine excreted in 24 hours.	Calculated amount of uric acid excreted in 24 hours.	No. of hrs. in which urine changed from acid to alkaline.	Color and Microscopical Examination of Urine.
									Grs.	Grs.	Grs.	Grs.			Grs.	Grs.	Grs.		
Sept. 29	7 P. M.	Calomel gr. xij, sulp. qui. gr. vij, castor oil in 4 hrs., sulph. qui. gr. xxv.	Hot, dry	120	32	79.0°	103.33°	106.0°	..	..	..	..	..	..	..	..	..	..	
" 30	1 P. M.	.. ..	Cool, relaxed	70	22	68.0	92.00	99.5	..	..	1290	23220	18	1009.5	1.0035	30952	1.3376	60	Light orange; after 50 hours, no deposit of urates or phosphates.
" 30	5 P. M.	Spirit of mindererus.	Chill	108	30	74.0	91.00	105.5	..	..	..	..	..	..	..	..	..	..	
" 30	8 P. M	Sulph. quinia gr. xx.	Hot, dry	108	32	73.0	103.50	105.0	28320	3.0035	1180	5100	8	1020.0	2.0000	15300	6.0000	60	Normal color; no deposit.
Oct. 1	11 A. M.	Sulph. quinia gr. v.	Cool, moist	76	23	70.0	95.00	98.5	24309	..	1014	19209	15	1011.0	..	30734	..	60	A shado higher than normal.
" 2	11 A. M	Calomel gr. vj, sulph. qui. gr. vj, castor oil in 4 hrs., sulph. qui. gr. xv.	Warm and moist	84	32	74.0	100.50	102.0	15810	9.3000	658	15810	24	1020.0	9.3000	..	..	20	Deposit of urates and phosphates.
" 3	11 A. M.	Snakeroot tea and sulphate of quinia.	Cool and moist	62	20	74.0	96.00	98.5	18180	8.1000	757	18180	24	1010.0	8.1000	..	..	20	Light yellow; phosphates and urates precipitated.
" 4	11 A. M.	Quassia and soda.	Normal	60	20	72.5	96.00	99.5	20520	..	855	20520	24	1018.0	..	..		..	Color normal; deposit.
" 5	11 A. M.	Quassia and soda.	Normal	62	21	70.0	96.00	99.3	30450	15.000	1268	30450	24	1015.0	15.000	..	..	..	Color normal; deposit.

TABLE II.

Observation.—(*i.*) American seaman; age 16; weight 125 lbs.; light hair, blue eyes, florid complexion; sanguine temperament. From U. S. cutter, which has been lying at the ship-yard in the low lands east of the city. Four nights ago, he slept on the Savannah River in an open boat; has not felt well since, and thinks that this was the cause of his sickness. The next morning felt badly; had pains in his bones and back, but no chill. These uncomfortable feelings were followed by fever, which intermitted yesterday. This morning had a slight chill, followed by fever.

Date.	Hour of day.	Medicine.	State of Skin.	State of Tongue.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Urine excreted in 24 hours.	Urine excreted hourly.	Specific gravity of urine.	Color and Reaction of Urine.
										Grs.	Grs.		
Oct. 5	11 A. M.	Cal gr. viij, castor oil in 4 hours, cit. potassa mixture, sulphate of quinia, gr. xv.	Hot, dry	Red, dry, rough	120	40	72°	105.75°	106.00°	..	..	..	Light orange color.
" 6	1½ P. M	Sulphate of quinia, gr. v.	Moist, soft, and relaxed	Moist, soft, and clean	64	20	73	94.50	99.00	..	..	1022	Reaction strongly acid in 70 hours.
" 7	1½ P. M.	Snakeroot tea, quassia, and soda.	Normal	Normal	62	20	72	94.75	99.20	8240	343.3	1030	Reaction alkaline in 16 hours; heavy deposit.
" 8	2 P. M.	Quassia and soda.	Normal	Normal	52	24	73	98.20	99.50	8721	363.3	1026	
" 9	12 M.	Quassia and soda.	Normal	Normal	52	24	73	98.20	99.50	15912	663.8	1024	

TABLE III.

OBSERVATION.—(*j.*) Englishman; age 27; height 5 feet 10 inches; weight 145 lbs.; muscular system well developed; sanguine temperament; occupation, steward on ship. Has been in Savannah three weeks. Says that he was taken yesterday, at 12 o'clock M., with cold feelings and headache. The chilly feelings lasted four hours, and were succeeded by fever which continued until 4 o'clock this morning. Four and a half hours after the subsidence of the fever (8½ o'clock A. M.), he shook violently. This chill was followed by fever which is now subsiding.

Date	Hour of day.	Medicine.	State of Skin.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Amount of urine excreted in 24 hours.	Urea excreted in 24 hours.	Uric acid excreted in 24 hours.	Fixed saline constituents in 24 hours.	Urine excreted in	Hours.	Specific gravity.	Urea.	Uric acid.	Fixed saline constituents.	Urine excreted hourly.	Calculated amount of urine excreted in 24 hours.	Urea calculated for 24 hours.	Uric acid calculated for 24 hours.	Fixed saline constituents calculated for 24 hours.
									Grs.	Grs.	Grs.	Grs.	Grs.			Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.
Oct. 9	8 P. M.	Sulph. of qui. gr. xx.	Warm and moist	98	..	72.0°	102.5°	103°	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 10	12 M.	.. ..	...	..	..	..	..	..	..	..	..	..	6144	16	1024	226.0	0.600	40.2	321	9216	340.0	0.90	60.10
" 10	½ P. M.	Spirit of mindererus and sinapisms	Chill	100	26	68.5	87.5	107	..	..	..	..	7021	½	1003	39.0	0 420	9.8	..	..	..	..	..
" 10	1 P. M.	.. ..	Hot	100	26	69.0	99.0	107	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 10	7 P. M.	Sulph. of qui. gr. xx.	...	..	..	67.0	102.0	..	18290	365.9	1.27	78.5	5075	6½	1015	99.4	0.250	28.5	760	20300	397.7	1.00	114.00
" 11	10 P. M.	Snakeroot tea	Cool, moist	88	22	..	..	..	..	..	..	..	9144	15½	1016	157.0	3.150	40.5	590	14630	251 4	5.04	64.80
" 12	11 A. M.	Quassia & soda	Cool, moist	84	20	..	..	..	..	..	..	..	15120	9	1008	..	..	..	1680	40219	..	..	..
" 13	10 A. M.	.. ..	Normal	68	16	78.0	98.0	99	28782	..	..	..	13662	14⅓	1012	101.8	2.025	29.7	912	21859	162.9	3.24	47.52
" 14	..	.. ..	Normal	64	16	..	..	..	16320	488.8	9.60	115.2	16320	24	1020	488.0	9.600	115.2	680	..	..	..	..

TABLE IV.

Observation.—(*k.*) American seaman, native of Maine; weight 140 lbs.; height 5 feet 8 inches; age 19; light hair and blue eyes; fair complexion. Has been in Savannah three weeks. Was taken with chill, followed by fever, yesterday at 12 o'clock M.; had another chill this morning at 4 o'clock. Oct. 10th, 11 o'clock A. M. Has a high fever now, and complains of pains in his head and bones. Skin very hot, but moist; pulse 112; respiration thoracic, labored; tongue slightly coated with fur. ℞.—Calomel, gr. x; sulph. of quinia, gr. vj. Mix, and administer immediately, and follow with castor oil in four hours. ℞.—Soda powders.

Date.	Hour of Day.	Medicine.	State of Skin and Tongue.	Pulse.	Respiration.	Specific gravity of urine.	Amount of urine excreted in	Hours.	Urea	Uric acid.	Fixed saline constituents.	Calculated amount of urine for 24 hrs.	Calculated amount of urea for 24 hrs.	Calculated amount of uric acid for 24 hours.	Calculated amount of fixed saline constituents for 24 hrs.	Reaction, Color, &c. of Urine.
							Grs.		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	
Oct. 10	7 P. M.	Sulph. of quinia, gr. x.	Skin hot, but moist; fever continues unabated.	..	..	1022	9198	10	222.5	3.96	87.30	22075	534.0	9.50	209.5	Clear orange color; still acid, with no deposit after 70 hrs.
" 11	1 P. M.	Sulph. of quinia, gr. x.	Skin cool and moist; papillæ of tongue red and enlarged, tongue soft, moist, and slightly coated with white fur.	74	26	1027	..	..	..	..	..	..	..	..	..	Reaction changed from acid to alkaline in 36 hours, and deposit of triple phosphate and urate of soda thrown down.
" 12	11 A. M.	Quassia & soda	Skin cool and moist; tongue clean.	72	20	1023	3580	7	132.0	1.75	21.70	12177	452.7	5.99	74.3	Reddish-orange color; reaction acid at end of 50 hours, and no deposit.
" 12	8 P. M.	Quassia & soda	Skin soft and normal.	64	16	1020	5100	..	..	..	..	..	..	..	..	Straw-colored.
" 13	11 A. M.	Quassia & soda	Normal.	..	..	..	5120	25	..	2.75	46.00	8192	..	4.40	73.6	Normal.

TABLE V.

OBSERVATION.—(*l.*) Irish seaman; black hair, black eyes, and florid complexion; height 5 feet 11 inches; weight 175 lbs. Has been staying on board the light-ship, and running up and down the Savannah River at all hours of the day and night. Says that he resided six years at Panama, but was never sick. Was taken with chill and fever two days ago, and the captain of the light-ship gave him several doses of drastic medicine.

Date.	Hour of day.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Am't of urine excreted during 24 hours.	Am't of urine excreted hourly.	Water excreted during 24 hrs.	Solid matters excreted during 24 hours.	Urea excreted during 24 hrs.	Uric acid excreted during 24 hours.	Extractive and coloring matters excreted during 24 hrs.	Fixed saline constituents excreted during 24 hrs.	Am't of urine excreted in	Hours.	Specific gravity.	Water.	Solid matters.
							Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.			Grs.	Grs.
Sept. 6	1 P. M.	118	20–32	85.00°	96.00°	101.5°	..	..	..	..	..	..	..	..	..	..	..	..	..
" 6	6 P. M.	120	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 7	10 A. M.	98	28	80.00	100.00	104.0	..	..	..	..	..	..	..	..	..	..	..	..	..
" 7	7 P. M.	108	24	82.00	103.75	105.0	..	..	..	..	..	..	..	..	2552	9	1020.80	2402	149.3
" 8	9 A. M.	78	18	75.00	98.50	100.5	14776	615	14015	760	361	4.240	326	68.0	12224	14	1018.70	11613	616.2
" 8	6 P. M.	88	18	76.00	93.00	104.5	18351	764	17453	898	392	7.560	398	98.8	6127	9	1021.20	5830	286.9
" 9	10 A. M.	76	20	75.00	97.75	99 5	15291	628	14517	773	351	5.040	341	75.0	9163	16	1018.20	8677	486.5
" 9	6 P. M.	76	22	87.00	97.50	99.8	15298	637	..	..	350	5.160	..	..	6135	8	1022.00	..	..
" 10	10½ A. M.	68	19	79.00	96 50	98.0	11240	468	..	..	176	5.400	..	..	5107	16	1021.50	..	..
" 10	7 P. M.	68	20	80.00	97.00	98.9	10209	425	..	..	126	3.300	..	..	5102	9	1020.40	..	..
" 11	11 A. M.	74	18	82.00	97.00	98.2	12250	510	..	..	200	6.500	..	..	7148	16	1021.20	..	..
" 11	6½ P. M.	67	22	78.75	97.83	99.0	11254	468	..	..	..	8.920	..	..	4106	7½	1026.50	..	..
" 12	12 M.	60	20	83.00	97.00	99.8	8194	341	..	..	..	10.120	..	..	4088	17	1022.15	..	..
" 13	11 A. M.	..	..	..	..	..	16962	706	..	..	..	..	..	..	..	..	..	..	..
" 14	4 P. M.	..	..	..	..	..	25335	1055	23971	1363	504	..	552	306.0	31669	30	1021.60	29965	1703.0

Date.	Hour of day.	Urea.	Uric acid.	Extractive and coloring matters.	Fixed saline constituents.	Calculated am't of urine for 24 hours.	Calculated am't of water for 24 hours.	Calculated am't of solid matters for 24 hrs.	Calculated am't of urea for 24 hours.	Calculated am't of uric acid for 24 hours.	Calculated am't of extractive and col'ng matters for 24 hrs.	Calculated am't of fixed saline constituents for 24 hrs.	Water in 1000 parts of urine.	Solid matters in 1000 parts of urine.	Urea in 1000 parts of urine.	Uric acid in 1000 parts of urine.	Extractive and coloring matters in 1000 parts of urine.	Fixed saline constituents in 1000 parts of urine.	Am't of urine excreted hourly.
		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.							Grs.
Sept. 6	1 P. M.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 6	6 P. M.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 7	10 A. M.	..	..	..	..	..	..	..	..	..	..	..	936	63.9	34.90	0.705	21.270	6.976	..
" 7	7 P. M.	81.6	1.000	54.4	12.235	6803	6405	397.9	217.7	2.666	144.9	32.610	941	58.5	31.90	0.391	21.350	4.780	283
" 8	9 A. M.	279.3	3.240	272.3	56.200	20903	19856	1047.0	477 0	5.540	466.0	96.150	950	50.0	22.80	0.265	22.283	4.600	566
" 8	6 P. M.	113.4	4.320	126.4	42.600	16335	15570	765.0	302.5	11.507	337.0	113.700	953	46 8	18.50	0.705	20.600	6.962	680
" 9	10 A. M.	237.4	0.720	215.9	32.400	13745	13015	729.0	356.0	1.080	324.0	48.600	946	53.0	25.90	0.078	23.500	3.539	572
" 9	6 P. M.	113.4	4.440	..	..	18405	..	..	340.0	13.320	..	..	..	..	18.40	0.723	..	..	766
" 10	10½ A. M.	63.0	1.000	..	..	7661	..	..	94.5	1.500	..	..	..	..	12.30	0.196	..	..	468
" 10	7 P. M.	63.0	2.300	..	..	13601	..	..	169.0	6.131	..	..	..	..	12.30	0.450	..	..	566
" 11	11 A. M.	137.0	4.200	...	41.190	10722	..	..	205.6	6.300	..	61.792	..	..	19.49	0.587	..	5.037	446
" 11	6½ P. M.	..	4.720	..	..	13139	..	..	..	15.104	..	..	..	..	..	1.149	..	..	534
" 12	12 M.	..	5.400	..	..	5768	..	..	..	7.619	..	..	..	..	..	1.320	..	..	240
" 13	11 A. M.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	706
" 14	4 P. M.	630.0	..	690.0	38.200	..	..	..	..	..	..	..	945	54.5	19.90	..	22.400	12.100	1055

TABLE VI.

Observation.—(*m.*) Frenchman; age 45; weight 120 lbs.; thin and spare; nervous temperament; complexion pale. Has been in Savannah three weeks; has been acting as nurse in the hospital two weeks. Sept. 15th, 12 o'clock M. Was taken with a chill at 8 o'clock A. M., attended with vomiting, and followed with high fever. Urine passed during the height and decline of the fever, orange colored, and diminished in amount.

Date.	Hour of day.	Skin, Medicine, Color of Urine, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Specific gravity of urine.	Amount of urine excreted in	Hours.	Urea.	Uric acid.	Fixed saline constituents.	Calculated am't of urine for 24 hrs.	Urea calculated for 24 hours.	Uric acid calculated for 24 hours.	Fixed saline constituents calculated for 24 hours.
									Grs.		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.
Sept. 16	12 M.	Apyrexia; skin cool.	..	..	..	..	..	1021.5	4086	24	..	0.400	..	4086	..	0.400	..
" 17	12 M.	Apyrexia; skin cool.	..	..	..	..	..	1021.7	6641	24	252.2	2.275	..	6641	252.2	2.275	..
" 18	12 M.	Apyrexia; skin cool.	..	..	88.0°	93.5°	99.0°	1023.0	6640	24	136.1	13.840	..	6640	136.1	13.840	..
" 19	12 M.	Convalescent. Continued to improve and was discharged September 23d.	..	..	89.5	96.5	98.0	..	7530	24	..	..	..	7530	..	..	..
Oct. 7	3¼ P. M.	Has returned; has had chill every day since the 5th inst., at 11 o'clock A. M.; calomel, gr. xij, sulphate of quinia, gr. xxv.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 9	3½ P. M.	The chill has returned; pulse very feeble, with difficulty counted; respiration irregular; lips and fingers blue.	92	..	75.0	83.0	101.5	..	..	..	..	..	..	..	..	..	..
" 9	6½ P. M.	Hot stage; pulse much fuller.	96	..	70.0	101.8	102.5	..	..	..	..	..	..	..	..	..	..
" 10	11 A. M.	Febrile excitement has almost entirely subsided; sulph. of quinia, gr. xxv; urine high colored, like new Madeira wine.	..	..	70.0	97.5	98.5	1022.0	8687	15	342.1	5.950	28.0	13899	547.3	9.520	44.8
" 12	11 A. M.	Pulse, skin, and tongue normal; convalescent.	..	..	..	..	..	1022.0	15330	24	349.2	11.250	76.5	15330	349.2	11.250	76.5

TABLE VII.

Observation.—(*n*.) Irish laborer; age 40; height 5 feet 8 inches; weight 145 lbs.; brown hair, gray eyes, and sallow complexion. Was in the hospital ten days ago with intermittent fever. Was discharged, but has returned, August 17th, at 12 o'clock M.

Date.	Hour of day.	Pulse, Tongue, Skin, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Specific gravity of urine.	Amount of urine excreted during 24 hours.	Uric acid.	Character of Urine.
									Grs.	Grs.	
Aug. 17	12 M.	Intermission. Skin cool and moist; tongue slightly furred.	60	20	..	..	..	..	..	..	
" 18	12 M.	Fever has returned; complains of great thirst, and pain in head; tongue coated in the middle with yellow fur, red at tip and sides; skin dry.	100	36	90°	106°	106°	..	..	..	Amount of urine excreted during fever in six hours, 7035 grains.
" 18	8 P. M.	Skin softer, but still very hot; fever continues.	104	..	..	..	..	1005	3000	a trace	Urine excreted during fever, clear and light colored.
" 19	12 M.	Skin cool; tongue covered with yellowish fur.	70	22	90	..	98	1014	2000	1.20	Amount of urine passed in seven hours of the intermission, 6089 grains; uric acid 0.48 grains.
" 20	..	Slight febrile excitement.	86	27	87	100	101	1017	14120	5.60	High color.
" 21	..	.. .. ..	72	17½	80	96	98	1009	14126	..	Heavy deposit of prismatic crystals of triple phosphate.

TABLE VIII.

OBSERVATION.—(*o.*) Irishman; age 18; brown hair and brown eyes; height 5 feet 6 inches; weight 125 lbs.; well-developed chest. Occupation, barkeeper in a sailors' boarding-house on the bay. Five days ago, attended a boat-race at Thunderbolt, and slept for two nights in an open boat. The second morning, after waking, felt badly and vomited.

DATE.	Hour of day.	MEDICINE.	STATE OF SKIN AND TONGUE.	Pulse.	Respiration.	Tem. of atmosphere.	Temperature of hand.	Temperature under tongue.	Specific gravity of urine.	Amount of urine passed in	Hours.	Water.	Urea.	Uric acid.	Extractive and coloring matters.	Fixed saline constituents.	Calculated am't of urine for 24 hrs.	Calculated am't of water for 24 hrs.	Calculated am't of urea for 24 hrs.	Calculated am't of uric acid for 24 hrs.	Calculated am't of extr've and col'ing matters for 24 hrs.	Calculated am't of fixed saline constituents for 24 hrs.	Color of urine.	DEPOSITS IN URINE.
										Grs.		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.		
Sept. 11	8 P. M.	Cal. gr. xij, castor oil in 4 hrs., sulp. qui. gr. x.	Tongue slightly furred; skin warm.	116	30	80°	102.5°	103.0°	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....
" 12	12 M.	Sulp. qui. gr. x.	Skin cool; tongue slightly coated with white fur.	84	24	83	98.5	99.0	1018.0	7126	16	6766.0	203.70	trace	110.3	45.8	10689	10149	305.5	trace	165 5	68.70	Deep orange red	Reaction decidedly acid after 60 hours, and no deposit.
" 12	8½ P. M.	....	Skin hot; tongue slightly furred.	100	24	82	102.5	103.9	1022.0	6138	8	..	..	..	..	..	18414	..	..	..	..	..	Deep orange inclining to red	No deposit.
" 13	11 A. M.	Sulp. qui. gr. xx.	Tongue moist; skin hot.	98	26	82	102.2	103.0	1020.0	7154	15	..	..	..	..	..	11446	..	..	..	..	..	Deep orange red	No deposit.
" 13	5½ P. M.	....	....	90	28	85	101.0	102.9	1022.0	4092	7	..	..	..	..	..	14029	..	..	..	..	..	Deep orange red	No deposit.
" 14	1 P. M.	....	Tongue slightly coated with white fur; skin moist and cool.	65	24	85	96.0	98.0	1021.0	10210	20	..	..	..	..	..	12252	..	..	..	..	..	Light orange	Reaction still very acid; no deposit.
" 15	10 A. M.	Quassia & soda.	Pulse, skin, and respiration normal; up and walking about the hospital grounds.	..	..	..	..	..	1019 7	11726	20	11291.3	161.04	8.624	204.2	60.4	14071	13550	200.01	16.35	237.1	72.77	Light orange	Reaction of urine changed from acid to alkaline in 12 hours, and let fall a heavy, shin'g deposit of triple phosphate; the crystals were numerous and beautiful.

TABLE IX.

OBSERVATION.—(*p.*) Pulse, respiration, temperature, and character of urine in intermittent fever.

No. of case.	Age.	Weight.	Height.	Date.	Hour of day	Medicine.	State of Skin and Tongue.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Specific gravity of urine.	Am't of urine excreted in 24 hours.	Uric acid.	Color of Urine.	Deposits in Urine.
	Yrs.	Lbs.	Ft. In.											Grs.	Grs.		
p	25	192	5 8½	Sept. 18	11 A. M.	Sulph. qui. gr. xx.	Chill is just going off.	112	28	90.5°	100.0°	104.0°	..	..	..	....	Reaction strongly acid.
				" 19	2 P. M.	.. ..	Skin cool and moist.	68	24	91.0	97.5	99.0	1008	18144	2.88	A shade higher than normal.	No deposit.
				Oct. 2	2 P. M.	Cal. gr. xij, sulph. qui. gr. vij.	Lips and hands purple; violent chill.	120	22	79.0	89.0	102.25	..	..	..	....	Do.
				" 3	2¼ P. M.	Sulp. qui. gr. xxv.	Skin hot and dry; tongue red at tip, but moist and soft.	100	26	77.6	105.0	106.0	..	..	..	....	Do.
				" 4	2 P. M.	.. ..	Skin cool; pulse full and soft.	58	20	76.0	96.5	98.5	1008	14112	..	Deep orange color.	Do.
				" 5	..	.. ..	Skin cool and normal.	..	..	..	..	..	1016	15290	..	Reddish orange.	Do.
				" 15	2 P. M.	.. ..	Skin hot; high fever.	..	..	..	..	..	1002	35070 12 hrs.	trace	....	Do.
q	18	150	5 9	Aug. 12	2 P. M.	Comp. blue pill and castor oil.	Face red; skin hot.	112	40	..	..	..	..	..	..	....	Reaction strongly acid; no deposit after 60 hours.
				" 14	..	Sulph. qui. gr. xv.	Tongue red at tip, furred and pointed.	112	..	88.0	104.0	106.0	..	..	..	....	Do. do.
				" 15	..	Sulph. qui. gr. xv.	Skin cool, moist, and relaxed.	92	26	88.0	98.0	99.7	..	..	..	....	Do. do.
				" 16	..	.. ..	Skin hot and moist.	112	..	..	..	..	1020	..	..	....	Do. do.
				" 17	..	.. ..	Skin cool and moist.	82	24	86.0	99.0	100.0	..	..	..	....	Do. do.
				" 18	..	.. ..	Skin warm and soft.	96	36	86.0	99.0	102.75	1020	..	..	High colored.	Do. do.
				" 18	8 P. M.	.. ..	In profuse perspiration.	90	..	..	..	..	..	..	..	Shade of Madeira wine.	Do. do.
				" 19	..	.. ..	.. .. ..	76	23	89.0	..	99.0	1021	..	..	Do.	Heavy deposit of urate of soda and triple phosphate.
				" 20	..	.. ..	.. .. ..	72	26	85.0	..	98.0	1020	..	..	Do.	Do. do.

TABLE IX.—Continued.

No. of case.	Age.	Weight.	Height.	Date.	Hour of day.	Medicine.	State of Skin and Tongue.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Specific gravity of urine.	Am't of urine excreted in 24 hours.	Uric acid.	Color of Urine.	Deposits in Urine.
	Yrs.	Lbs	Ft. In.											Grs.	Grs.		
				Sept. 18	8 P. M.	Cal. gr. xii.	Tongue red at tip and edges; papillæ enlarged, coated with white fur.	96	22	84.0°	103.0°	104.0°	..	..	..	Deep orange.	Reaction strongly acid.
				" 19	11 A. M.	Sulp. qui. gr. xxx.	Skin warm and moist; tongue the same.	100	36	86.0	103.0	104.0	1020.0	9840	8.160	....	Do. do.
r	17	150	5 8	" 20	11 A. M.		Skin moist.	76	21	84 0	96.0	100.0	1023.0	23460	..	Deep orange red.	Do. do.
				" 21	12½ M.	.. ..	Profuse perspiration.	82	24	83.0	102.0	104.5	1021.0	7161	9.800	Do.	Do. do.
				" 22	11 A. M.	Sulph. qui. gr. xx.	.. .. ..	72	21	81.0	98.0	99.2	1011.0	..	..	....	
				" 22	7 P. M.	.. ..	.. .. ..	78	28	80.5	99.0	102.0	1018.0	..	..	....	Deposit of triple phosphate.
				Sept. 18	8 P. M.	Sulph. qui. gr. xx.	Skin moist; tongue pointed, red at tip, and furred.	90	28	84.0	103.0	104.0	..	..	..	High colored; deep orange.	
				" 19	11 A. M.	.. ..	Do. do.	80	21	86.0	98.0	100.5	1020.2	9792	4.600	Do.	
s	24	147	..	" 20	11 A. M.	Sulph. qui. gr. xv.	Tongue red at tip and edges, pointed, and coated with white fur.	80	26	84.0	100.0	101.5	1023.0	19437	..	Do.	
				" 21	12½ M.	.. ..	.. .. ..	80	24	83.0	96.8	100.5	1021.0	9180	36.000	Do.	Heavy deposit of urate of soda and triple phosphate.
				" 22	..	.. ..	.. .. ..	74	17	..	..	..	1017.0	22374	..	Do.	Do. do.
				July 8	2 P. M.	.. ..	Skin hot and dry; tongue dry; papillæ enlarged, covered with thick yellow fur.	88	..	82.0	105.0	106.0	..	..	..	Deep orange red.	After standing several d'ys, a slight deposit of mucus and vegetable cells.
				" 9	4 P. M.	Sulph. qui. gr. xv.	Skin moist and cool.	58	30	81.0	95.9	101.0	1012.0	..	4.480	Reddish orange.	Reaction decidedly acid; no deposit of urates or phosphates.
t	26	154	5 7	" 9	6 P. M.	.. ..	Do. do.	58	30	..	..	..	1015.0	..	7.400	Do.	No deposit.
				" 10	11 A. M.	.. ..	Skin hot and dry.	66	29	80.5	102.0	104.0	1012.3	..	2.723	Do.	
				" 13	8 P. M.	Sulph. qui. gr. xv.	.. .. ..	48	20	81.0	99.0	100.0	1020.0	9180	..	Orange.	
				" 14	11 A. M.	.. ..	.. .. ..	44	21	79.0	..	99.0	1021.0	10212	13.000	Light orange.	Heavy deposit of urate of soda and triple phosphate.

Case (u.) illustrating the diminution of the constituents of the urine, when the forces have been reduced by the continued action of the malarial poison.

Irish laborer; light-brown hair, brown eyes; has been in America seven years, and in Savannah three years; age 22, medium height. Has been living and making bricks in a low, miasmatic situation. Says that he has suffered with chill and fever for six weeks. Complexion sallow and anæmic; lips, gums, and tongue pale. He is exhausted by slight exertions, and complains of great weakness.

Sept. 16th, 12½ o'clock P.M. Pulse, 88; respirations, 24. Temperature of atmosphere, 87° F.; temp. of hand, 100.5; temp. under tongue, 101.25.

17th, 11½ o'clock P. M. Pulse, 72; respirations, 20. Temperature of atmosphere, 86° F.; temp. of hand, 90°; temp. under tongue, 98°. Has just awoke from sleep, and is in a profuse perspiration.

	16.027 grains of urine, excreted in 24 hours (sp. gr. 1001.7), clear and limpid, contained	1000 parts of urine contained
	Grains.	
Water	15,958.568	995.730
Solid matters	68.432	4.270
Urea	42.680	2.664
Uric acid	1.280	0.074
Extractive and coloring matters . .	18.776	1.171
Fixed saline constituents . . .	5.696	0.356

The reduction of the nervous and physical forces was attended by a reduction in the amounts of the solid constituents of the urine. ℞.—Infusion of Virginia Snakeroot f℥xvj; brandy f℥vj; sulph. of quinia gr. xv.—Mix. Take a wineglassful five times a day. ℞.—Citrate of iron gr. iv, three times a day.

17th, 12 M. Pulse, 72; respirations, 20. Temperature of atmosphere, 88° F.; temp. of hand, 98.5°; temp. under tongue, 99.5°. Amount of urine excreted during the last twenty-four hours under the action of the diuretic and tonics, 14,645 grs.; sp. gr., 1010. Urea in 14,645 grs. of urine, 196.910; uric acid in 14,645 grs. of urine, 7.975; urea in 1000 parts of urine, 12.445; uric acid in 1000 parts of urine, 0.544. The infusion of snakeroot, and sulphate of quinia and citrate of iron, have produced an increase of the solid constituents of the urine.

Case (v.) illustrating the diminution of the constituents of the urine when the forces have been reduced by the continued action of the malarial poison.

German laborer, age 30; height 5 feet 5 inches; weight, in health, 112 pounds; light hair, blue eyes; small, delicate man. Has been in the United States three years, and in Savannah three months. Has been "keeping store" on the river, near the rice mill. Was taken sick with chill and fever two months ago. Complexion, anæmic. Complains of great weakness. Lips, gums, and tongue pale; tongue coated with white fur.

10th, 11 o'clock A. M. Says that he had a chill yesterday.

℞.—Sulph. of quinia gr. v, every three hours, up to gr. xv.

11th, 12 o'clock M. Skin cool; in a profuse perspiration. Pulse 76, respirations, 19. Temperature of atmosphere, 85° F.; temp. of hand, 94°; temp. under tongue, 98. Color of urine a shade higher than normal. Sp. gr. 1014.5.

	5072 grains of urine, excreted in 17 hours, contained	7157 grains of urine, calculated for 24 hours, contained	1000 parts of urine contained
	Grains.	Grains.	
Water	4886.160	6895.783	963.462
Solid matters	185.340	261.514	36.538
Urea	65.475	92.385	12.907
Uric acid	2.750	3.880	0.552
Extractive and coloring matters	102.485	144.607	20.225
Fixed saline constituents . .	14.631	20.642	2.884

In this case, as in the preceding, we see that the depressed state of the forces consequent upon the action of the malarial poison, was attended by a marked diminution of the solid constituents of the urine.

12th, 12½ o'clock P. M. Pulse, 72; respirations, 19. Temperature of atmosphere, 84° F.; temp. of hand, 97.25°; temp. under tongue, 99.9°. Sp. gr. of urine, 1011.3. After sixteen hours a copious deposit of urate of soda and triple phosphate.

	13,652 grains of urine, excreted in 24 hours, contained	1000 parts of urine contained
	Grains.	
Water	13,242.437	970.000
Solid matters	409.563	30.000
Urea	209.520	15.316
Uric acid	19.710	1.443
Extractive and coloring matters . .	158.485	11.676
Fixed saline constituents	20.265	1.567

Under the action of the sulphate of quinia, the urea, uric acid, extractive and coloring matters, have been increased in amount.

II. REMITTENT FEVER.

PROPOSITION VII. *The phenomena of the cold stage, preceding the hot stage of remittent fever, are similar to those of the cold stage of intermittent fever.*

During the cold stage of remittent fever, there is a rapid, feeble pulse, full rapid respiration, and hot trunk, and cold extremities. The temperature of the extremities is reduced far below that of the trunk, and even below the standard of health. *The diminution of the capillary circulation and reduction of temperature of the extremities precede the aberrated nervous and muscular phenomena, denominated chill.* The higher the temperature of the trunk, during the cold stage, the more rapid will be the equalization of the circulation and temperature; the higher the temperature of the trunk during the cold stage, and of the extremities and trunk during the subsequent hot stage (stage of equalization of the circulation and chemical action), the milder and shorter will be the attack, if judiciously treated, provided there be no complication, as congestion of the brain, or obstinate vomiting; whenever there is a want of correspondence between the circulation, respiration, and chemical changes, the patient is in danger.

PROPOSITION VIII. *As far as my observation extends, the most important difference between the cold stage of remittent, and that of intermittent fever, is a difference of degree and not of kind; the phenomena of the cold stage of remittent fever are more protracted than those of intermittent fever; the sympathetic system is not so rapidly aroused, and the circulation in the capillaries of the extremities is not so rapidly restored in remittent, as in intermittent fever.*

We have before shown that the alterations of the blood are more profound in remittent than in intermittent fever, and that *in both diseases the alterations in the blood precede the disturbances of the circulation and respiration and action of the sympathetic nervous system;* it follows then, as a necessary consequence, that the phenomena of the cold stage should be more prolonged in remittent than in intermittent fever.

Proposition IX. *In remittent as in intermittent fever the increase of the action of the pulse and respiration is attended by an elevation of temperature, and the elevation of temperature corresponds more accurately with the increased actions of the circulatory and respiratory systems in intermittent than in remittent fever—that is, the pulse and respiration are more accelerated in remittent fever, whilst the temperature does not rise higher than that of intermittent fever.*

The explanation of this phenomenon lies in the fact that the blood is most altered in remittent fever, and that the chemical changes of the capillaries are most disturbed, and probably the power of the blood to absorb oxygen, or the force of the circulation in the capillaries of the lungs, more diminished in remittent than in intermittent fever.

Proposition X. *The elevation of the temperature is more persistent in remittent than in intermittent fever.*

The alterations of the blood induced by the malarial poison are greater, and the effects upon the liver, spleen, sympathetic and cerebro-spinal nervous systems, and upon the heart, are greater than in intermittent fever, and hence more vigorous chemical changes are needed for the alteration and elimination of these altered offending products.

Proposition XI. *The pain upon pressure of the epigastrium is more acute, and the vomiting more obstinate, and the cerebral symptoms more common and dangerous, in remittent than in intermittent fever.*

Proposition XII. *The secretions of the mouth are more completely checked, and the tongue is drier, redder, and rougher to the feeling, in remittent than in intermittent fever.*

In the active stages of remittent fever, the tongue, in many cases, especially if it be the first attack of fever, presents, upon those portions which are clean, a brilliant scarlet color, and dry, glazed surface; the papillæ are enlarged; the fur which frequently coats the tongue is of a yellowish and brownish-yellow, and sometimes black, color, and almost always dry; the tongue, in many cases, feels, when the finger is passed over it, as dry and as rough and harsh as the surface of a rough board.

Proposition XIII. *The glowing tongue of remittent fever is not an index of inflammation.*

It indicates arrest or disturbance of circulation in the capillaries

of the superficial parts of the tongue. The secretions of the mucous membrane have been checked; the moisture is evaporated by the elevated temperature; the circulation in the superficial capillaries is thus retarded, and they become filled with colored blood-corpuscles, which give the bright color to the tongue.

PROPOSITION XIV. *The secretions of the salivary glands and mucous membrane of the mouth are not only more diminished, but they are also more perverted in remittent than in intermittent fever. The acidity of the saliva is greatest in remittent fever.*

The solution of the question, What checked the secretions of the salivary glands and mucous membrane of the mouth? involves the consideration of the relations of the malarial poison to the salivary glands and mucous membrane of the mouth; involves the consideration of the relations of the altered products of the blood, resulting from the action of the malarial poison, to the salivary glands and mucous membrane of the mouth; involves the consideration of the relations of the malarial poison and altered elements of the blood to that portion of the nervous system which presides over the circulation and secretion of the salivary glands and mucous membrane of the mouth.

PROPOSITION XV. *The coma, delirium, and severe pain in the head so often present in the severe cases of remittent fever, are, as a general rule, not indicative of inflammation of the brain, but of the stagnation of the blood and perversion of the chemical changes in the capillaries of the brain, and of the action of the altered blood upon the nervous elements, and of the direct action of the malarial poison upon the nervous structures.*

The truth of this proposition is established by the effects of stimulants and sulphate of quinia in the severest forms of remittent fever.

In numerous cases, I have seen, under the free administration of stimulants and sulphate of quinia, the dry, red, glowing, parched, hard, rough tongue, become moist, clean, and pale; the tenderness upon pressure of the epigastrium disappear; the circulation and respiration abate in force and frequency; the dry, harsh, hot skin become soft, relaxed, cool, and covered with perspiration; the severest headache relieved; and the dulness, and even profound coma and wild delirium, of the intellectual faculties vanish, and the brain restored to the exercise of its normal functions.

PROPOSITION XVI. *The changes of the urine in remittent fever are the same in kind, but different in degree from those of intermittent fever.*

As a general rule, the amount of urine excreted during the active stages, and during the earliest period of intermission, when the temperature of the trunk and extremities sinks below the normal standard, is less than that of health; and during convalescence (especially under the action of depurants) the amount of urine excreted is greatly increased.

The color of the urine is much deeper in remittent than in intermittent fever, and varies from deep orange to deep red and reddish brown, and in some cases almost black. The intensity of the color is greatest during the active stages, and diminishes during convalescence.

The acidity of the urine is greater in remittent than in intermittent fever. The urine excreted during the active stages is far more acid than that of convalescence or of health, and retains its acidity and resists decomposition much longer. When the fever intermits and the cause of the disease is removed, and the patient is convalescent, the urine then excreted rapidly undergoes decomposition, and in a few hours the reaction changes from acid to alkaline, and the phosphates, which, as in intermittent fever, are most abundant in the urine of convalescence, are thrown down in the form of beautiful silvery, shining crystals, which resemble, when held in the sunlight, particles of shining silver.

The increased temperature and correspondingly increased chemical changes of the active stages of remittent fever were attended by an INCREASE OF THE UREA, not only above the normal standard, during rest and a deprivation of food, but also above the standard of active health, and far above the standard of intermittent fever. When the temperature falls below the normal standard in the earliest stages of convalescence of remittent fever, the urea, as in the similar changes in intermittent fever, decreases in amount.

In the majority of the cases, the URIC ACID *was diminished* both with and without the action of the sulphate of quinia, during the active stages of remittent fever, when the pulse was full and rapid, and the respiration full and accelerated, and the temperature elevated.

In almost every case of remittent fever, as the fever declined, the uric acid increased above the standard of health both with and without the action of the sulphate of quinia.

The formation of deposits of the urates of soda and ammonia and of the triple phosphates (*critical discharges*) in the urine of remittent fever is similar in all respects, takes place at analogous periods of the disease, and is due to the same causes as that of intermittent fever.

The coloring and extractive matters *were diminished* during the active stages and increased during the subsidence of the fever. In several hundred examinations of the urine of the different forms of malarial fever, albumen was found in only one case, which was complicated with typhoid fever. This fact is important in its bearing upon typhoid and yellow fever.

These propositions will now be supported and illustrated by the following cases:—

TABLE X.

OBSERVATION.—(*w.*) English seaman; age 25; weight 140; height 5 feet 6 inches; black hair, florid complexion. Sailed from N. Y. to Darien; remained in Darien five days, during which time he slept on board the vessel lying in the Altamaha River; sailed from Darien, and arrived in Savannah twelve days ago. During the day, has been running on a steam-tug up and down the Savannah River, from its mouth to the city, and has slept during the night on the bay. Was taken with chill September 6th, at 10 o'clock A. M. This was a severe attack; the cerebral symptoms were well marked. The stupor, and the dry red tongue, and harsh dry skin, and the disturbances of the sympathetic system and of the respiration and circulation, were relieved by the free administration of stimulants and sulphate of quinia.

DATE.	HOUR OF DAY.	MEDICINES.	STATE OF TONGUE.	STATE OF SKIN.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Am't of urine excreted during	Hours.	Am't of urine excreted hourly.	Specific gravity of urine.	Water.	Solid matters.
										Grs.		Grs.		Grs.	Grs.
Sept. 10	7 P. M.	.. .. ..	Dry, red; superior portion coated with black fur.	Dry, hot.	90	48	80.0°	103.00°	105.00°	..	..	..	..	..	..
" 11	11 A. M.	Sulphate of quinia gr. xx, soda powders.	Dry, red, and glazed; feels rough.	Dry, harsh, hot.	88	34–40	82.0	103.25	105.00	8160	16	510	1020.0	7618	541
" 11	7 P. M.	Soda powders, sulphate of quinia gr. x.	Tip cleau and red; superior portion coated with dark fur.	Moist, hot.	90	40–44	81 0	104.00	104.80	5098	8	637	1019.6	4764	333
					..	..	..	..	..	13258	24	552	1019.8	12383	874
" 12	12 M.	Calomel gr. xij, castor oil in 4 hrs., sulph. qui. gr. xl.	Cleaner and moist; still red at tip aud edges.	Moist.	70	26–36	83.0	100.75	102.50	15285	17	899	1019.0	14475	899
					..	..	..	..	..	20383	24	849	1019.3	19240	1142
" 12	9 P. M.	Sulphate of quinia gr. xv, snakeroot tea f℥xvj, tablespoonful every 4 hours.	Moist; still redder than normal.	....	70	53	83.0	99.16	101.50	..	..	..	1020.0	..	..
" 13	11 A. M.	Brandy, sulphate of quinia, aud snakeroot tea.	Do. do.	....	52	48	85.0	97.00	100.00	..	..	..	1024.0	..	..
" 13	6 P. M.	Do. do.	Slightly coated with yellow fur.	....	60	26–32	..	..	..	..	..	..	1022.0	..	..
" 14	1 P. M.	Do. do.	Normal.	Normal.	58	28	87.0	99.00	102.00	15375	19	809	1025.0	..	..
" 15	10 A. M.	Quas. & soda, snakeroot tea.	Do.	Do.	50	24	84.0	94.50	99.00	6607	20	330	1016.5	6230	376
" 15	7 P. M.	Do. do.	Do.	Do.	47	27	87.0	96.00	99.00	5121	9	569	1018.2	4946	174
" 16	12 M.	Do. do.	Do.	Do.	46	20–26	87.0	97.00	99.00	4599	17	270	1022.2	4292	306
" 16	12 M.	.. .. ..	.. ..	....	..	..	..	..	..	9720	24	405	1020.0	9238	481
" 16	8 P. M.	Quas. & soda, snakeroot tea.	Normal.	Normal.	47	28	87.0	95.90	99.00	4080	8	510	..	..	..
" 17	11 A. M.	Do. do.	Do.	Do.	44	24	84.5	96.00	99.00	8712	15	514	1018.0	8139	572
" 18	12 M.	.. .. ..	.. ..	....	44	24	86.0	96.25	99.00	15903	24	662	..	..	..
" 19	12 M.	.. .. ..	.. ..	....	44	24	88.5	97.00	99.00	24240	24	1010	..	..	..
" 20	12 M.	.. .. ..	.. ..	....	..	..	..	..	..	32320	24	1346	1010.0	..	..
" 22	12 M.	.. .. ..	.. ..	....	44	22	84.0	97.80	99.12	23300	24	929	1008.0	..	..

TABLE X.—Continued.

Date.	Hour of day.	Urea.	Uric acid.	Extractive and coloring matters.	Fixed saline constituents.	Calculated amount of urine for 24 hours.	Calculated amount of water for 24 hours.	Calculated amount of solid matters for 24 hours.	Calculated amount of urea for 24 hours.	Calculated amount of uric acid for 24 hours.	Calculated amount of extractive and coloring matters for 24 hours.	Calculated amount of fixed saline constituents for 24 hours.	Color of Urine.	Length of time required for the change from the acid to alkaline.	Deposits in Urine.
		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.			
Sept. 10	7 P. M.	..	..	..	..	..	..	..	..	..	..	..	.. ..	..	
" 11	11 A. M.	349	3.20	168	20	12240	11428	811	523	4.80	253	30	High colored, like new Madeira wine.	70	After 40 hours, a very small deposit of prismatic crystals of triple phosphate.
" 11	7 P. M.	223	1.45	90	18	15294	14294	999	669	4.35	270	54	Do. do.	70	Do. and urate of soda.
		572	4.65	258	38	..	..	..	..	..	..	..	.. ..	70	Do. do.
" 12	12 M.	567	6.00	95	140	21567	20435	1131	800	8.46	134	197	Brownish red.	70	Do. do.
		790	7.45	185	158	..	..	..	..	..	..	..	.. ..	..	
" 12	9 P. M.	..	..	..	..	..	..	..	..	..	..	..	.. ..	..	
" 13	11 A. M.	..	..	..	..	..	..	..	..	..	..	..	Orange colored.	15	Moderately heavy deposit of triple phosphate, and urate of soda and ammonia.
" 13	6 P. M.	..	..	..	..	..	..	..	..	..	..	..	Do. do.	15	Do. do.
" 14	1 P. M.	538	8.55	..	35	..	..	..	679	10.79	..	45	Do. do.	15	Heavy deposit.
" 15	10 A. M.	222	4.22	123	26	8038	7584	452	267	5.07	147	31	Deep orange.	15	Do.
" 15	7 P. M.	52	6.25	94	20	13652	13186	465	140	16.66	252	55	Orange.	15	Do.
" 16	12 M.	150	2.70	120	32	6490	6057	432	212	3.79	169	46	Light orange.	12	Do.
" 16	12 M.	203	8.95	214	53	..	..	..	..	..	..	..	Nearly normal.	..	Do.
" 16	8 P. M.	..	..	..	..	12240	..	..	..	..	..	..	.. ..	..	Do.
" 17	11 A. M.	123	5.69	281	161	13940	13023	916	197	9.11	449	258	Normal.	..	Do.
" 18	12 M.	..	35.65	..	..	..	..	..	..	..	..	..	Do.	..	Do.
" 19	12 M.	..	..	..	..	..	..	..	..	..	..	..	Do.	..	Do.
" 20	12 M.	..	..	..	..	..	..	..	..	..	..	..	Do.	..	Do.
" 22	12 M.	..	..	..	..	..	..	..	..	..	..	..	Do.	..	Do.

Observation.—(*x.*) Irish seaman; age 21; height 5 feet 4 inches; weight 125 pounds; brown hair, brown eyes, sallow complexion. Has been in Savannah three weeks, and has been sick three days. This is his first trip to Savannah during the summer season.

Oct. 12, 12 M. Complains of great weakness and pain in his back and bones; says that he had no chill and no fever during the three days of indisposition previous to his entrance into the hospital. Pulse 80, full.

℞.—Sulph. of quinia gr. v every three hours up to gr. xv.

13th, 12 M. Did not rest well last night. Complains of pain in his head and bones. Had a chill two hours ago. Tongue clean, red, dry, and rough; papillæ enlarged. Some tenderness of epigastrium. Skin hot and dry. Pulse, 118; respirations 24 to 26, irregular, thoracic.

℞.—Calomel gr. x. Follow with castor oil in four hours.

℞.—After fever remits give sulphate of quinia gr. v every three hours up to gr. xx.

14th, 12 M. Medicine acted twice. Tongue clean and very red. Patient is not so restless; complains of great weakness; has taken gr. xx of sulphate of quinia. Temperature of skin normal.

℞.—Brandy f℥viij; sulph. of quinia gr. xv; infusion of Virginia snakeroot f℥viij.—Mix. Tablespoonful every four hours.

15th, 12 M. Had an increase of fever yesterday afternoon, which was accompanied with severe pain in his head and bones.

Now he is restless and nervous; countenance uneasy, anxious. All his motions are indicative of restless, uneasy, anxious feeling; complains of great thirst; tongue as red as scarlet, at 9 o'clock this morning it was dry and glazed, at the present time (three hours afterwards) it is a little moister and softer; lips dry, red, and rough. Epigastrium tender upon pressure; trunk and head very hot; extremities only moderately warm. Complains of pain in the small of the back, and in the knees and bones of his legs. Pulse 106, feeble; respirations 30 to 34, irregular, labored, thoracic, panting. Temperature of atmosphere, 74° F.; temp. of hand, 101°; temp. on axilla, 105°. The temperature under the tongue could not be taken on account of his restlessness. There is a great want of co-ordination between the circulation, respiration, and temperature of the extremities. The capillary circulation and chemical changes are impeded. Reaction of saliva, acid.

℞.—Four cut cups to epigastrium. Four cut cups over the lumbar regions and spine.

℞.—Sinapisms to the extremities.

Urine high-colored, of a deep brownish-red color. Sp. gr., 1028; reaction decidedly acid.

Amount of urine passed during the last 30 hours . .	15,430 grs.
" " " " 24 " . .	12,344 "
" " hourly " "	515 "

	15,430 grains of urine, passed during 30 hours, contained	12,344 grains of urine, passed during 24 hours, contained	1000 parts of urine contained
	Grains.	Grains.	
Urea	727.500	582.000	47.178
Uric acid	9.300	7.440	0.603
Fixed saline constituents .	75.000	60.000	4.863

7½ o'clock P. M. Lies in a stupor, muttering to himself, and is with great difficulty aroused. When aroused, answers incoherently and says that he feels very well. Temperature of extremities below the normal standard, cool; temperature of head and trunk normal; tongue of a bright red color; great tenderness of epigastrium; pressure here arouses him more quickly than violent shaking. Pulse 100, feeble; respirations, 32.

℞.—Two cut cups to each temple. ℞.—Blister over the epigastrium, 6 inches by 4 inches, and another to the back of the neck, 4 inches by 5. ℞.—Apply sinapisms to extremities. ℞.—Brandy and infusion of Virginia snakeroot, and spirit of mindererus, f℥ss; of each alternately every half hour, until reaction is established. ℞.—Sulph. of quinia, gr. v, every three hours up to gr. xlv.

Amount of urine passed during the last 7½ hours . .	4,072 grs.
" " hourly " " . .	543 "
Calculated amount of urine for 24 hours . . .	13,030 "

Sp. gr. of urine 1018; high colored and strongly acid. After standing 70 hours there was no deposit, and the reaction was still decidedly acid.

	4072 grains of urine, passed during 7½ hours, contained	13,030 grains of urine, calculated for 24 hours, contained	1000 parts of urine contained
	Grains.	Grains.	
Urea	151.320	483.224	37.161
Uric acid	1.888	6.036	0.461

Oct. 16th, 9 o'clock A. M. Much better; intellect clear. The cups, blisters, and stimulants, and sulphate of quinia, have restored the capillary circulation to its normal state.

12½ o'clock P. M. Continues to improve; urine high-colored, of a deep orange-red; reaction strongly acid; after standing fifteen hours, a slight deposit of mucus-corpuscles; and after one hundred hours, a small light yellow deposit of mucus-corpuscles, urate of ammonia and vegetable cells. The presence of the mucus-corpuscles in the urine is due to the absorption and action of the cantharadin upon the mucous membrane of the genito-urinary apparatus. In several cases of severe remittent fever, I have discovered, after the action of blisters, numerous spermatozoa in the urine. Sp. gr. of urine, 1021.

	11,231 grains of urine, passed during the last 16 hours, contained	16,746 grains of urine, calculated for 24 hours, contained	15,303 grains of urine, excreted during 24 hours, contained	1000 parts of urine contaiued
	Grains.	Grains.	Grains.	
Urea	357.445	535.667	508.760	31.820
Uric acid . . .	5.500	8.250	7.380	0.489
Fixed saline constituents	53.900	80.850	64.680	4.799

Amount of urine passed during the last 16 hours, . .	11,231 grs.
" " hourly " " . . .	702 "
Calculated amount of urine for 24 hours, ...	16,746 "
Actual amount of urine excreted during the last 24 hours, .	15,303 "
" " " hourly " " .	637 "

3 o'clock P. M. Skin dry but soft. Has taken xlv grs. of sulphate of quinia. This has not yet exerted its characteristic effects upon the skin. Tongue red but moist and soft; blisters have drawn well. Serum from blistered surfaces of a golden color; patient complains of difficulty in passing his urine. This is due to the absorption and action upon the mucous membrane of the bladder and urethra, of the cantharidin absorbed from the blistered surfaces. Pulse, 84; respiration, 16. Temperature of atmosphere, 69.5° F.; temp. of hand, 99°; temp. under tongue, 99.5°. ℞.—Sulphate of quinia, gr. v, every three hours, up to gr. xv. ℞.—Continue spirit of mindererus, and brandy, and snakeroot tea, f℥ss of each alternately every two hours. Diet, mutton soup and arrowroot.

17th, 12 M. Continues to improve; tongue red, but clean and soft. Pulse 70; respiration 16. Temperature of atmosphere, 67° F.; temp. of hand, 97.33°; temp. under tongue, 98.5°. Color of urine deep red, reaction decidedly acid. Sp. gr. 1022. Reaction of saliva strongly acid.

Amount of urine passed during the last 24 hours . . 8176 grs.
" " hourly " " . . 382 "

	8176 grains of urine, excreted during 24 hours, contained	1000 parts of urine contained
	Grains.	
Urea	185.240	22.578
Uric acid	4.400	0.538
Fixed saline constituents . . .	40.000	4.892

The reduction of the temperature, and of the action of the respiratory and circulatory system, has been attended by a corresponding diminution of the constituents of the urine.

18th. Continues to improve; "feels quite well, with the exception of great weakness." His appetite has returned; tongue clean, moist, and soft, and not so red. Pulse 72; respiration 18.

℞.—Continue brandy and infusion of Virginia snakeroot.

Color of urine orange, much lighter; reaction in twenty hours, decidedly alkaline. Sp. gr. 1020. Heavy light yellow deposit, after standing twenty hours, of urate of soda and triple phosphate.

Amount of urine passed during the last 24 hours . . 20,400 grs.
" " hourly " " . . 850 "

Diet, soft-boiled eggs, milk punch, arrowroot, and mutton soup.

18th, 12 M. Skin, pulse, and respiration normal. Urine orange colored. Sp. gr. 1020. Reaction alkaline in twelve hours; heavy light yellow deposit in twelve hours.

Amount of urine excreted during the last 24 hours . 15,300 grs.
" " hourly " " . . 637 "

20th.

Amount of urine passed during the last 24 hours . . 17,374 grs.
" " hourly " " . . 724 "

	17,374 grains of urine, passed during 24 hours, contained	1000 parts of urine contained
	Grains.	
Uric acid	11.730	0.675
Fixed saline constituents . . .	93.500	5.381

Sp. gr. of urine 1022. Reaction alkaline in twelve hours; orange color. After standing twenty-four hours, a light yellow deposit of triple phosphate and urate of soda were thrown down.

21st, 9 A. M. The patient is dressed, and has been walking about the hospital grounds. His pale, sallow complexion and feeble gait

show the effects of the malarial fever. Urine of a light orange color, only a shade darker than normal. Sp. gr. 1024. Reaction, just after its deposition, acid; in ten hours afterwards, alkaline. This change gave evidence of the formation of ammonia, and was attended by the formation of crystals, presenting, when the urine was held in the sun, a sparkling appearance, like particles of silver. Under the microscope these crystals were found to be well formed, prysmatic crystals of triple phosphate. The microscope also revealed a few crystals and globular masses of the urates of soda and ammonia.

	9234 grains of urine, excreted during 12 hours, contained	18,468 grains of urine, calculated for 24 hours, contained	1000 parts of urine contained
	Grains.	Grains.	
Urea	229.599	458.198	25.128
Uric acid	7.740	15.480	0.935
Fixed saline constituents .	91.800	183.600	9.941

Amount of urine passed during 12 hours . . .	9,234 grs.
" " hourly " . . .	769 "
Calculated amount for 24 hours	18,468 "

The following table will present the relations of the pulse, respiration, and urine:—

TABLE XI.

Date.	Hour of day.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Specific gravity of urine.	Amount of urine excreted in	Hours.	Urea.	Uric acid.	Fixed saline constituents.	Calculated amount of urine for 24 hours.	Calculated amount of urea for 24 hours.	Calculated amount of uric acid for 24 hours.	Calculated amount of fixed saline constituents for 24 hours.	Color of Urine.	Reaction, Deposits in Urine, &c.
								Grs.		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.		
Oct. 13	12 M.	118	24–26	..	..	..	..	..	..	..	..	..	..	..	..	..		
" 15	12 M.	106	30–40	74.0°	101.0°	105.0°	1028	15430	30	727.50	9.300	75.00	..	..	..	..	Deep brownish red color.	No deposit after 110 hours.
" 15	12 M.	..	..	..	..	..	..	12344	24	582.00	7.440	60.00	..	..	..	..		
" 15	7¼ P. M.	100	32	..	..	..	1018	4072	7½	151.32	1.888	..	13030	483.22	6.036	..	Do.	Do. do.
" 16	12¼ P.M.	84	16	69.5	99.0	99.5	1021	11231	16	357.44	5.500	53.90	16746	535.60	8.250	80.850	Deep orange.	After 15 hours, a small deposit of mucus-corpuscles; after 100 hrs., small deposit of vegetative cells and urate of soda.
" 16	12½ P.M.	..	..	..	..	..	1021	15313	24	508.70	7.380	64.65	..	..	..	..		
" 17	12 M.	70	16	67.0	97.33	98.5	1022	8176	24	185.20	4.400	40.00	..	..	..	..	Deep red.	
" 18	12 M.	72	16	..	..	..	1020	20400	24	..	..	..	..	..	..	..	Orange.	Heavy deposit of urate of soda and triple phosphate, and alkaline reaction after 20 hours.
" 19	12 M.	Normal	Normal	..	Normal	Normal	1020	15300	24	..	..	..	..	..	..	..	Do.	Do. do.
" 20	12 M.	Normal	Normal	..	Normal	Normal	1022	17374	24	..	11.730	93.50	..	..	..	..	Light orange.	Reaction alkaline in 12 hours; heavy deposit.
" 21	9 A. M.	Normal	Normal	..	Normal	Normal	1024	9234	12	229.50	7.740	91.80	18468	458.10	15.480	183.600	Very light orange, almost normal color.	Reaction changed from acid to alkaline in 10 hours; heavy deposit of urate of soda, and ammonia, and triple phosphate.

Observation.—(*y.*) Irish seaman, aged 38; weight 160 lbs.; height 5 feet 6 inches; stout, muscular man; first trip to Savannah. Has been in Savannah ten days, during which time he has worked on a ship lying along the shore of the river, and has slept on Bay Street at night.

Oct. 14, 2 P.M. Was taken sick four days ago, with pain in his head and in all his bones, accompanied with fever, which has continued unabated up to the present time. Has had no chill. Took a dose of calomel three days ago, which acted freely. Now his face is much flushed; skin hot and dry; head very hot; complains greatly of pain in his head; eyes look heavy and stupid; tongue bright red and dry; voice hoarse and guttural; says that he has been vomiting, and can retain nothing upon his stomach. ℞.—Cut cups to each temple, and two to back of neck, and four over the region of the stomach.

If the cut cups do not relieve the vomiting, administer a tablespoonful of equal parts of milk, lime-water, and the aqueous solution of the acetate of morphia.

15th, 11 A.M. Says that he feels better; the cut cups over the temples and back of neck relieved the pain in his head, and the cut cups over the region of the stomach checked the vomiting. Face is not so much flushed; tongue still very red, dry, and rough; no tenderness upon pressure of epigastrium, although the state of his tongue would lead us to look for it; skin soft and not so hot. This morning at 3 A. M. the fever remitted with perspiration. Pulse, 76; respiration, 20. Has taken xxvj grains of sulphate of quinia. ℞.—Neutral mixture; drink *ad libitum.*

8 o'clock P.M. Has been vomiting this evening. This was arrested by milk and lime-water, and acetate of morphia. Tip of tongue for three-fourths of an inch clean, dry, glazed, and of a brilliant red color—the remainder of the tongue is coated with brownish-yellow fur, which is dry and harsh to the feeling; face flushed and hot; skin, upon all parts of the body, hot, pungent, and dry; no tenderness upon pressure of epigastrium. The calomel has acted several times, and is still acting. Pulse, 94; respiration, 26. ℞.—Soda powders. Urine high colored, like new Madeira wine.

16th, 1 o'clock P. M. Did not rest during the night; was tossing about, and getting up out of the bed every few moments, and was and is now tormented by unquenchable thirst; appears to be completely exhausted. Tip of tongue clean, dry, scarlet-colored, glazed, shining—posterior portion (base) of tongue coated with brown and

black fur, dry, harsh, and as rough as sand-paper. The under surface of the tongue is dry, glazed, and shining. There is no more moisture in his tongue, and in the walls of the mouth, than if they were made of glass. Skin hot, dry, and harsh to the feeling.

The temperature under the tongue cannot be taken, on account of the dry condition of the lips and tongue. Bowels are loose—stools watery and yellow; no pain upon pressure of epigastrium. Complains of no pain anywhere. There is a great tendency to stupor.

Although his tongue is glowing red, and his face is flushed, and there is an inclination to stupor, still I will administer sulphate of quinia and stimulants, because he is exhausted, and the appearance of the mucous membrane of his mouth and tongue is indicative, not of inflammation, but of derangement of the capillary circulation, and of alterations in the nervous system and blood.

℞.—Brandy f℥viij; infusion of Virginia snakeroot f℥viij; sulphate of quinia gr. xv.—Mix. f℥j every hour. ℞.—Spirit of mindererus f℥j every hour. ℞.—Mustards to extremities. ℞.—Sulphate of quinia gr. v; camphor gr. ij.—Mix. Every three hours. ℞.—Soda powders.

Amount of urine passed during the last 17 hours . .	10,210 grs.
" " hourly " " . .	600 "
Calculated amount of urine for 24 hours . . .	14,406 "

Sp. gr. 1020. Reaction decidedly acid; urine high colored, like new Madeira wine. No deposit after thirty hours; after sixty hours, a slight deposit of mucous corpuscles and triple phosphate. Crystals of nitrate of urea, silvery and well formed. Hydrochloric acid showed the presence of coloring matters in large amount.

	10,210 grains of urine, excreted during 17 hours, contained	14,406 grains of urine, calculated for 24 hours, contained	1000 parts of urine contained
	Grains.	Grains.	
Urea	320.980	452.581	32.305
Uric acid	0.200	0.382	0.019
Fixed saline constituents .	30.000	40.330	2.938

17th, 11 o'clock A.M. Much better. Tip of tongue clean—superior portion coated with fur; tongue moister, softer, and not so red as on yesterday; face much less flushed; the burning thirst has almost entirely disappeared; has no pain anywhere, and says that he has an appetite; no tenderness of epigastrium. Has taken grs. xxx of the sulphate of quinia since 1 o'clock P.M., October 16th.

Pulse, 68; respiration, 18. Pulse much fuller; respiration more regular and soft. Temperature of atmosphere 68° F.; temperature of hand 98°; temp. under tongue 98°.5.

Here we see, that under the action of the sulphate of quinia and stimulants, his respiration has become regular; his pulse slower and fuller; his burning thirst diminished; his glowing tongue and flushed face paler; his parched mouth moister; his intellect brighter; his exhausted forces more active; and all the secretions and functions more regular. Urine high colored. Decided acid reaction. Sp. gr. 1022. No deposit after standing thirty hours. After eighty hours a small light-yellow deposit of triple phosphate and urate of soda.

Amount of urine excreted during the last 24 hours . 12,264 grs.
" " hourly " " . . 511 "

	12,264 grains of urine, passed during 24 hours, contained	1000 parts of urine contained
	Grains.	
Urea	315.250	30.846
Uric acid	5.200	0.440
Fixed saline constituents . . .	34.800	2.846

℞.—Continue camphor and sulphate of quinia, and brandy and snakeroot tea. Diet, milk-punch, wine-whey, arrowroot, and mutton soup.

18th, 12 o'clock M. Rested well during the night; had no fever, and his skin was in a good perspiration. The great thirst has entirely disappeared. Tongue still redder than normal, but moist and soft, and the yellow fur coating the posterior portion is breaking up and cleaning off; skin moist, and normal in temperature and feeling. Pulse and respiration normal. Dressed himself, and has been walking in the ward. Urine of a deep orange color, several shades lighter than that voided yesterday. Sp. gr. 1019. Reaction slightly acid.

Amount of urine passed during the last 24 hours . . 12,737 grs.
" " hourly " " . . 614 "

℞.—Continue brandy and snakeroot tea, tablespoonful every three hours. Diet, soft-boiled eggs, milk punch, mutton soup, arrowroot, and rice.

19th. Dressed, and walked about the ward.

20th. Walked about one mile into town; says that he feels well; urine orange color. Sp. gr. 1020. After standing twelve hours, a

heavy light-yellow deposit of triple phosphate and urate of soda. 1000 parts of urine contained uric acid 0.607. Fixed saline constituents 3.529.

21st. Says that he took a slight cold yesterday, during the walk into the city; urine orange color. Sp. gr. 1019.

Amount of urine passed during the last 17 hours . .	13,247 grs.
" " hourly " " . .	770 "
Calculated amount of urine for 24 hours . . .	19,495 "

	13,247 grains of urine, excreted during 17 hours, contained	19,595 grains of urine, calculated for 24 hours, contained	1000 parts of urine contained
	Grains.	Grains.	
Urea	181.568	290.508	12.992
Uric acid	6.110	9.770	0.461
Fixed saline constituents .	96.900	154.040	7.199

This patient had no return of fever, and was discharged a few days subsequently. This case sustains not only the conclusions, but also the treatment of the two preceding cases of remittent fever.

Six Cases from the same Small Vessel, illustrating the Injurious Effects of the Use of Calomel, and the neglect of Stimulants and Sulphate of Quinia in Remittent Fever; the Relations of the Pulse and Respiration and Temperature in Malarial Fever; the Effects of Stimulants and Sulphate of Quinia upon the severe Cerebral Symptoms; the Depressing Influences of the Malarial Poison; and the Diversity of the Manifestation of its Effects in Men living in the same Small Vessels, and exposed, in an equal manner, to the Malarial Influence.

Observation.—(x 1.) American seaman from U. S. cutter; age, 24; height, 5 feet 10 inches; weight, 150 pounds; brown hair, brown eyes. This is his first summer in Savannah. Has been employed as a sailor on the United States revenue cutter, which has been cruising during the summer, up and down the Savannah River.

Ten days ago, the cutter was struck by lightning and was placed in the dry dock, at the ship yard, on the river, east of the city. This ship yard is located on the Savannah River, about five hundred yards from the eastern boundary of the city in a malarious district which was formerly under the rice (wet) culture; now the surrounding lowlands are protected from overflows by dams, and are under dry culture. The banks of the river, at this locality, are

coated with mud composed in large measure of animal and vegetable matters; the banks and bottom of the canal, in which the ships are floated at high water, also contain large quantities of similar mud. The crew of the cutter slept on board one night after she was placed in dry dock. The crew consisted of ten healthy seamen, and out of this number six were taken sick in the course of ten days. Whilst the cutter continued in the stream the men were healthy, but as soon as they were exposed to the exhalations of the mud, and low grounds, they were taken sick.

September 24, 1857. Has just entered the hospital, and says that he had a slight chill yesterday, followed by fever. Tongue coated with brownish-yellow dry fur. Pulse, rapid; intellect, dull. Says that his bowels have not been moved for several days.

℞.—Calomel gr. xv; castor oil in four hours.

25th. Medicine acted freely. Has fever. Tongue still coated with fur, but a little more moist. The fur shows a disposition to come off in patches. Pulse, accelerated; intellect continues dull.

℞.—Sulph. of quinia gr. v, every three hours, up to gr. xv. Soda powders.

26th. Has been passing his feces in bed, and lies in a comatose condition.

℞.—Cut-cups to back of head. ℞.—Sinapisms to extremities; blisters to back of neck and epigastric region. ℞.—Infusion of snakeroot, and sulphate of quinia. ℞.—Calomel gr. xxiv; opium gr. ij.—Mix. Divide into twelve pills, and administer one every two hours.

27th. Continues comatose. Pulse 106, small and feeble. The blisters drew finely. *The blisters and sinapisms failed to arouse this patient, and he died this afternoon at* 1 *o'clock P. M.*

AUTOPSY TWENTY HOURS AFTER DEATH.

Exterior.—Full; limbs round; subject apparently not at all emaciated; skin of the superior (uppermost) portions of the body presented the usual appearance, whilst the skin of the inferior (dependent) parts presented a mottled, purplish appearance. This was due to the settling of the blood under the action of gravity.

Head.—Dura mater presented the usual appearance.

Arachnoid membrane not opalescent, but presented the usual transparency. Bloody serum was effused between the arachnoid membrane and pia mater.

Bloodvessels of pia mater congested with blood.

Ventricles of brain, almost completely filled with reddish serum. Bloodvessels of the superior portions of the brain, more congested with blood than those of the inferior portions.

Substance of the brain presented the usual appearance and consistency, considering the length of time since death.

Chest.—Heart and lungs normal.

Abdomen—Liver.—Color of the exterior appeared to be normal (perhaps a shade darker than usual), with the exception of two slate-colored spots. The largest of these slate-colored spots was four inches in diameter, and situated upon the anterior surface of the right lobe, whilst the smallest was situated upon the posterior surface of the left lobe. When an incision was made into the surface of the liver, through these spots, the structures presented a bronze color for the depth of a quarter of an inch. In all other parts of the liver, the cut surface presented a color only a shade deeper than normal.

Spleen, enlarged, softened, and of a dark slate color.

When the mud of the spleen was exposed to the atmosphere, a part retained the dark-purplish and reddish-brown color, whilst another smaller portion changed to an arterial hue. The difference between these two portions of the splenic mud were clearly seen when a section of the organ was exposed for several hours to the action of the atmosphere. The other portion of the mud of the spleen did not change its color. It is probable that this phenomenon was due to the fact, that the blood had been but recently effused into the spleen. The portions first effused had lost the power of changing to the arterial hue, whilst those last effused had not lost this power.

Kidneys, normal.

Alimentary Canal.—The mucous membrane of the alimentary canal, from the œsophagus to the anus, presented the normal color, and showed no signs whatever of congestion or inflammation.

CONCLUSIONS.

(1.) This case illustrates the rapid and powerful action of the malarial poison.

(2.) The brain and its membranes appeared to be normal, with the exception of the serous effusion which was entirely inadequate to account for the cerebral disturbance during life; the liver, with the exception of the small spots, appeared to be normal in structure; the affection of the spleen was recent; and the ali-

mentary canal, from the mouth to the anus, bore no marks of inflammation, and yet this strong, hearty young man fell a victim to the malarial poison.

The malarial poison appeared to act in this case, directly upon the nervous centres of the cerebro-spinal and sympathetic nervous systems.

(3.) The treatment of this case was radically defective—it was wanting in energy. *The effects of the disease were those of exhaustion, and not of inflammation and excitement. The chemical changes of the elements were interfered with, and the relations of the forces, as a necessary consequence, disturbed. The manifest indication was to stimulate the exhausted nervous system, and excite those chemical changes by which the forces are generated, which work the animal machinery.*

The blisters and sinapisms, and cut-cups, and small doses of sulphate of quinia, were right, as far as they went. The last doses of calomel were decidedly wrong, and worse than useless; they simply worked in conjunction with the malarial poison. Large doses of brandy, carbonate of ammonia and sulphate of quinia, should have been administered promptly and energetically, in conjunction with the blisters and sinapisms. The following case, which resembled this one in all respects, will illustrate, in a forcible manner, these conclusions:—

Observation.—(x 2.) Seamen from the United States revenue cutter, and a shipmate of the previous case; and the remarks which were made with reference to the history of that case, apply also to the present one. Age 26; light hair, blue eyes, florid complexion; height, 5 feet 11 inches; weight, 160 lbs. This is his first summer in these regions.

September 25, 1857. Has been sick two days; says that he was suffering with a thick eruption of prickly-heat. This disappeared suddenly and then the fever appeared. Has fever now.

℞.—Calomel gr. xv; castor oil in four hours.

26th. Medicine acted freely; heat of skin much less; tongue heavily coated with yellow fur, tip and edges very red; intellect dull; appears to articulate with difficulty.

℞.—Sulph. of quinia, gr. v every three hours, up to gr. xv. Infusion of Virginia snakeroot.

27th. Intellect still dull; tongue presented the same coated appearance. Pulse 83.

℞.—Calomel gr. x; sulph. of quinia gr. v. Mix and administer immediately.

28th, 10 o'clock A. M. Was delirious during the night, and it was necessary to use much force to keep him in bed. Appears to be much worse this morning, and continues delirious; tongue, heavily coated and very red at tip and edges. Pulse, 86. No pain upon pressure of epigastrium.

℞.—Blister to epigastrium and back of neck. ℞.—Calomel gr. xxiv; opium gr. ij.—Mix. Divide into twelve powders, and administer one every two hours.

7 o'clock P. M. Appears to be very weak and stupid. When aroused by shaking, whines and mutters incoherently. Pulse, 82; respiration, 20; skin dry; tongue presented the same appearance. *It is evident that unless the calomel be abandoned, and a more vigorous method of treatment adopted, this patient will die just as the previous case.*

℞.—Two cut-cups to each temple; sinapisms to extremities. ℞.—Brandy f℥viij; infusion of Virginia snakeroot f℥viij; sulphate of quinia gr. xv. Mix and administer a tablespoonful every half hour. ℞.—Sulph. of quinia gr. v every three hours up to gr. xx.

29th, 11 o'clock A. M. The stimulants and sulphate of quinia have been productive of much good. Tongue, although very red, and dryer and rougher than normal, is moister and softer than it was yesterday. During the night, slept soundly, and this morning his skin relaxed and was bathed in a copious perspiration. Intellect clearer. Pulse, 78; respirations, 15. Temperature of atmosphere 80° F.; temp. of hand, 99. Has taken during the last eighteen hours, forty grains of sulphate of quinia. ℞.—Give 20 more grains of sulphate of quinia during the next 20 hours, and continue the brandy and infusion of Virginia snakeroot, tablespoonful every hour. Diet, beef-soup and tea.

7 o'clock P. M. Continues to improve, and says that he is much better. The blisters have drawn and discharged golden colored serum. Intellect more active, but still much duller than usual. Tongue red, dry and harsh, feels like sand-paper—superior portion coated with yellow fur; face much flushed; reaction of saliva decidedly acid; urine high colored. Pulse, 80; respirations, 16. Temperature of atmosphere, 78.5° F.; temp. of hand, 100.33.

℞.—Mustard to extremities. Stop sulphate of quinia. Continue brandy and infusion of Virginia snakeroot. Diet, milk punch, and brandy and arrowroot.

30th. Says that he is much better. Pulse, 79; respirations, 16. Temperature of atmosphere, 70° F.; temp. of hand, 97.5; temp.

under tongue, 100. Tongue still very red, but more moist. Skin dry; reaction of saliva acid.

Urine, of a bright red color, and decided acid reaction—sp. gr. 1022. Uric acid in 1000 parts, 0.538.

℞.—Continue stimulants and nutritious diet.

Oct. 1st, 11 o'clock A. M. Rested well during the night, and continues to improve. Complains of great weakness. Tongue much softer. Pulse, 70; respirations, 14. Temperature of atmosphere, 71° F.; temp. of hand, 98; temp. under tongue, 99.5. Urine only a shade higher colored than normal, reaction acid—sp. gr. 1010. Uric acid in 1000 parts, 0.0099.

℞.—Continue brandy and infusion of snakeroot tea. Administer 15 grs. of the sulphate of quinia during the next fifteen hours.

2d, 11 o'clock A. M. Surface of blister red and raw; tongue cleaning off; papillæ enlarged and distinct; bowels torpid. Pulse 60; respirations 13, slow and full. It is probable that the frequency of the respiration is diminished by the blistered surface. Temperature of atmosphere, 76° F.; temp. of hand, 97.75; temp. under tongue, 99.5.

℞.—Continue stimulants and nutritious diet, milk punch and mutton soup.

Urine, of a bright red color, sp. gr. 1020—turbid after standing several hours. Amount passed during the last twenty-four hours, 13,260 grs.

3d, 11 o'clock A. M. Pulse, 62; respiration, 14. Temperature of atmosphere, 76° F.; temp. of hand, 98°; temp. under tongue, 99.25°. Reaction of saliva acid; urine of a deep orange color—heavy, light-yellow deposit after standing a few hours. The acid has greatly diminished—reaction alkaline after standing a few hours. Amount passed during the last twenty-four hours, 15,330 grs.; sp. gr. 1022. Uric acid in 15,330 grs. of urine, 10.5 grs. Uric acid in 1000 parts of urine, 0.684. Bowels have not been moved for four days.

℞.—Calomel gr. viij; sulph. of quinia gr. v. Castor oil in four hours. Continue stimulants and infusion of snakeroot.

4th. Dressed and walking about the ward. Tongue moist and soft, and only a little redder at the tip than usual. Pulse, 60; respiration, 12. Blister raw, and slow in healing. Urine orange colored, reaction slightly acid, when first voided, but rapidly changes to the alkaline, and lets fall a heavy deposit after standing a few hours.

℞.—Quassia and soda. Full diet.

5th. Urine, orange colored; sp. gr. 1024. Heavy deposit—reaction of saliva very slightly acid.

8th. Entirely restored to health. Pulse, 48; respiration, 14. Temperature of atmosphere, 73° F.; temp. of hand, 97°; temp. under tongue, 99.5°.

CONCLUSIONS.

(1.) Although the pulse of this patient, at first sight, did not appear to have been much accelerated, when compared with the pulse in other cases of malarial fever, still it was greatly accelerated. The pulse was unusually slow in health, only 48 to the minute. The respiration was also very slow in health, 14 to the minute. The temperature of the surface was not greatly elevated.

(2.) Aside from the cerebral symptoms, there was nothing to alarm the practitioner, except the state of the tongue. The prominent symptoms, as in the previous fatal case, from the same vessel, were connected with the brain.

(3.) Active purgation and alterative doses of calomel, so far from benefiting, were, as was conclusively demonstrated, by careful examinations and analyses of all his symptoms, working in conjunction with the malarial poison, and rapidly bringing on a fatal termination. Stimulants, blisters, sinapisms, and large doses of sulphate of quinia, administered without any regard to the state of the tongue and brain, so far from increasing the cerebral disturbance, diminished it rapidly. Under the vigorous use of these active remedies, the dry, red tongue became moist, soft, and pale—the pulse was diminished in frequency, and became fuller—the dry skin became moist, and the delirium entirely disappeared.

These facts demonstrate conclusively that the action of the malarial poison in this case was that of depression and not of inflammation.

Observation.—(x 3.) American seaman from United States revenue cutter; companion of the two former cases. Taken sick at the same time. Age 23; brown hair, dark eyes, florid complexion; height 5 feet 7 inches; weight 155 lbs.; large chest, and stout muscular limbs.

September 25th, 1857. Was taken sick two days ago. His attack commenced with a prolonged chilly feeling, followed in the course of six hours with fever. Has fever now.

℞.—Calomel gr. x; sulphate of quinia gr. v.

26th. Medicine operated freely. Complains of pain in his head.

Tongue coated with fur; pain upon pressure of epigastrium. Pulse 88.

℞.—Apply sinapism over epigastric region; and administer infusion of red pepper.

27th. Much better; febrile excitement much less. Complains of slight pains in his bones and bowels.

℞.—Sulph. of quinia gr. v, every three hours, up to gr. xv; infusion of Virginia snakeroot.

28th. Has no fever. Give fifteen more grains of sulph. of quinia.

29th, 11 o'clock A. M. Much better.

7 o'clock P. M. Within the last two hours has taken a change for the worse. Intellect wandering. Complains of great pain in his head. Pulse 92, feeble; respiration, 32. Reaction of saliva intensely acid. The secretions of the mucous membrane of the mouth are almost entirely dried up, and it is with difficulty that sufficient saliva is obtained to moisten the litmus paper. Tongue, where the fur is absent, very red—it is dry, harsh, and rough to the touch. Pain upon pressure of the epigastrium. Head and trunk hot, and extremities cool.

℞.—Sinapisms to extremities and epigastric region; cut-cups to temples and back of head.

℞.—Sulphate of quinia gr. vij, every three hours, up to gr. xl. Administer brandy and infusion of Virginia snakeroot, freely. Diet, brandy and arrowroot.

30th, 11 o'clock A. M. The mustards and stimulants have aroused the intellect, and rendered the dry, parched tongue moist, and diminished the frequency of the pulse and respiration. Pulse 68, rather feeble; respirations, 22. Temperature of atmosphere, 80° F.; temp. of hand, 95.5°; temp. under tongue, 97°. Skin slightly moist, and cool to the touch; face much flushed; surface of head cool, although from its congested, florid, red appearance, we would judge it to be hot. The temperature of the trunk and extremities is below the normal standard, notwithstanding that the pulse and respiration are much more rapid than in health. During the night he was delirious, and it was difficult to keep him in bed.

The blood from the cut-cups appeared to be normal under the microscope, and showed no signs of inflammation.

℞.—Continue stimulants and sulph. of quinia. Diet, milk punch, brandy, and arrowroot.

October 1st, 11 o'clock A. M. Continues to improve under the

action of the stimulants and sulphate of quinia. Tongue moister and softer. Pulse 66, rather feeble; respirations, 20. Temperature of atmosphere, 71.5° F.; temp. of hand, 95°; temp. under tongue, 97.15°. Complains of weakness. Rested well during the night, and has had no pain in his head since the application of the cut cups. Urine orange-colored; sp. gr. 1013.

℞.—Continue stimulants and nutritious diet.

2d, 12 o'clock M. Tongue moist and clean, redder than normal. Pulse 62, regular, full and soft; respirations, 20. Temperature of atmosphere, 76.5° F.; temp. of hand, 98°; temp. under tongue, 99°. Reaction of saliva, decidedly acid. Urine, orange-colored and clear, reaction decidedly acid; sp. gr. 1014. Amount excreted during the last twenty-four hours, grs. 21,210.

℞.—Continue. Full diet.

3d. Face not so much flushed. Tongue clean, moist, soft, and approaching the usual color. Respirations, 19. Temperature of atmosphere, 76.5° F.; temp. of hand, 96.5°; temp. under tongue, 98.8°. Reaction of saliva decidedly acid.

Color of urine, reddish-orange; after standing several hours, let fall a light yellow deposit; sp. gr. 1017.

℞.—Continue stimulants and infusion of Virginia snakeroot tea.

4th, 12 o'clock M. Up, and walking about the ward. Urine, orange colored; the change from the acid to the alkaline reaction took place in the course of a few hours, and a heavy deposit was thrown down. Amount of urine passed during the last twenty-four hours, 15,270 grs.; sp. gr. 1018. Pulse 54, slow and full; respirations, 14.

℞.—Quassia and soda.

5th, 11 o'clock A. M. Tongue, pulse, respiration and skin normal. Color of urine, light orange; sp. gr. 1020; reaction of saliva, acid.

9th. Entirely restored to health. Pulse, 43; respirations, 15. Temperature of atmosphere, 72° F.; temp. of hand, 96.5°; temp. under tongue, 99.75°.

Observation.—(x 4.) Irish seaman from United States revenue cutter, age 19; height 5 feet 7¼ inches; weight 145 pounds; light-brown hair, gray eyes, fair complexion.

Oct. 4th. Was taken sick four days ago; his attack was two days later than that of his companions. Has had no chill, but has suffered with pain and dizziness in the head; face flushed. Pulse, 100; respirations, 20. Tongue coated with yellow fur, tip and

edges red; papillæ enlarged. No tenderness of epigastrium. Skin hot.

℞.—Calomel gr. xij; sulph. of quinia gr. vj. Mix, and administer immediately, and follow with castor oil in four hours. As soon as the medicine has commenced to act, give sulph. of quinia gr. v every three hours up to gr. xx.

5th. Much better. Head relieved. Skin in a profuse perspiration. Reaction of sweat and saliva decidedly acid. Pulse, 104. Skin hot, but moist, and relaxed. Respirations 24, full, thoracic. No tenderness upon pressure of epigastrium. Tongue redder and dryer than normal. Medicine operated four times. Has taken thirty grains of sulphate of quinia.

℞.—As soon as fever remits, give brandy and infusion of Virginia snakeroot.

6th. Continues to improve. Pulse, 96. Skin warm, but moist. Continue stimulants.

The febrile excitement subsided and there was no return, and this patient was discharged a few days afterwards.

Observations.—(*x* 5, 6.) Two stout, athletic young seamen, from the United States revenue cutter, who contracted their sickness simultaneously with the four seamen just mentioned.

One suffered with a slight attack of intermittent fever, and remained in the hospital only a few days.

The other suffered also with intermittent fever, but of a severer type.

In this case, the chill was well marked, by a hot trunk and cold extremities, and great disturbance of the sympathetic and cerebrospinal nervous systems; and in the succeeding stage of febrile excitement, the pulse was full and strong, the respiration accelerated and the animal temperature correspondingly elevated; and in the intermission there was a marked subsidence of the febrile excitement.

At first sight, the severe chill—the full, bounding pulse—the thoracic respiration, and the hot and parched skin, would excite the belief that the patient was in danger. Such an opinion would have been erroneous, for these phenomena signified powers of resistance.

This case yielded far more readily to the action of the sulph. of quinia than the former cases from the cutter.

Conclusions drawn from an Examination, Analysis, and Comparison of these Six Cases of Malarial Fever, occurring in the Crew of the United States Revenue Cutter.

(1.) Whilst the revenue cutter was cruising about the mouth of the Savannah River, the crew remained healthy; but as soon as they were exposed to the exhalations of the low grounds and marshes, they were attacked by malarial fever. This fact demonstrates that a special cause resided in a special locality, capable of producing a special disease.

(2.) There was a remarkable uniformity in the symptoms of four out of the six young men from the cutter who were attacked with fever.

In these cases, the malarial poison appeared to act either directly or secondarily, powerfully upon the nervous centres of the sympathetic and cerebro-spinal systems.

The action of the malarial poison was depressing, rather than inflammatory. Whatever diminished the forces, acted in conjunction with the malarial poison. Whatever stimulated the nervous system, excited the action of the heart, excited the capillary circulation, excited and increased the chemical changes of the nutritive fluids and organs and tissues, acted directly antagonistic to the action and effects of the malarial poison.

(3.) A rapid feeble pulse, rapid respiration and low temperature, and wandering intellect, are always dangerous symptoms, which signify a perversion of the functions, an interference with the normal chemical actions, which generate the forces, and an unconditional surrender to the fatal poison.

(4.) A rapid, full pulse, accelerated respiration, and a corresponding development of heat, are favorable symptoms, and signify an effort on the part of nature to get rid of the poison. *The fever is not the disease—it is an effect of the action of the malarial poison upon the living organism, and signifies a power of resistance.*

(5.) The differences in the symptoms of these cases show that men living on the same small vessel, and exposed in an equal manner, will not suffer alike. The effects of the poison will depend, in great measure, upon the nature of their vital and physical endowments.

III. CONGESTIVE FEVER.

Pernicious Fever.—Malignant Fever.

These terms do not designate distinct diseases, but peculiar manifestations of one disease, malarial fever.

The complete prostration of the vital and physical forces; the reduction of animal temperature both in the trunk and in the extremities; the cold, clammy sweat; the rapid, feeble pulse; the rapid thumping action of the heart, and the sudden intervention of the most alarming cerebral symptoms, may occur gradually or suddenly in either intermittent or remittent fever, and may be induced by several distinct causes acting singly or in combination.

Proposition XVII. *The malarial poison may produce such profound alterations in the blood, and such profound impressions upon the sympathetic and cerebro-spinal systems, and upon the fibres of the heart, that both the capillary circulation and the general circulation will be greatly deranged, the chemical changes in the capillaries and organs from which the nervous and muscular forces are developed, arrested, and the temperature of the trunk diminished.*

Proposition XVIII. *The malarial poison may produce such derangements in the blood and its containing vessels, that fibrinous coagula will be formed in the heart and large bloodvessels, and produce suddenly and without previous warning, the phenomena denominated congestive.*

We have before illustrated this proposition by several striking cases of fibrinous concretions in the heart and large bloodvessels during life.

Proposition XIX. *The action of drastic purgatives or of an emetic or profuse bloodletting, may act in conjunction with the malarial poison and induce the phenomena denominated congestive, pernicious or malignant.*

Proposition XX. *As far as my observations extend, there is always a want of co-ordination between the actions of the circulation and respiration and animal temperature in congestive fever.*

The respirations are accelerated, full, and often panting and heaving, varying from 30 to 50 in the minute; the pulse beats from 120 to

160, and feels like a delicate thread, or is so small that it cannot be counted; the heart thumps irregularly and spasmodically against the walls of the chest, as in some cases of narcotic poisoning; the circulation in the capillaries is arrested; the temperature of the trunk, notwithstanding the full and rapid respiration, sinks below the normal standard; the temperature of the extremities sinks far below the normal standard, and the surface is covered with a cold clammy sweat.

PROPOSITION XXI. *The phenomena of congestive fever differ from those of the cold stage of intermittent and remittent fever in the want of elevation of the temperature of the trunk.*

This distinction is most important as a diagnostic and prognostic sign.

PROPOSITION XXII. *The phenomena of congestive fever are due to depression of the fever, and not to excitation, and should be treated accordingly.*

The characters of the urine are not so readily determined in congestive fever, on account of the restlessness, and often delirium of the patients.

In some cases it is increased and of a light color. The color of the urine does not, as in remittent and congestive fever, correspond with the severity of the disease. The changes in the urine during congestive fever point to profound disturbances in the chemical changes of the capillaries. In a case which we shall relate, the characters of the urine were completely altered.

The following cases will illustrate some of the phenomena and some of the principles of treatment of congestive fever.

In presenting these cases, the author would again disclaim any attempt to present all the various phenomena of malarial fever.

CASE ILLUSTRATING THE CHANGES OF THE BLOOD IN MALARIAL FEVER, AND THE DISTURBANCES OF THE PULSE AND RESPIRATION IN CONGESTIVE FEVER, AND THE EFFECTS OF STIMULANTS AND SULPHATE OF QUINIA.

American seaman: native of Boston; age 21; weight 150; height 5 feet 10 inches; dark brown hair, brown eyes; muscular system, moderately well developed. This is his first trip to Savannah. Has been in Savannah ten days. During this time has been sleeping at night on the deck of the ship in the open air. The captain compelled all his men to sleep on board the ship, which was lying at the saw-mill, opposite the low marshy shore. Was taken sick

four days ago. The crew consisted of eight; four of the crew slept on deck, and the same number in the cabin. The former are now sick, whilst the latter are well.

September 26th, 1857. Tongue dryer than normal, and coated with yellow fur; complexion sallow. Pain upon pressure of epigastrium. Has some fever, and appears to be very weak.

℞.—Sinapism over epigastric region.

℞.—Sulphate of quinia gr. v, every three hours, up to gr. xv.

27th. Has taken a change for the worse. Has been passing his water in bed, and is in a comatose state. When the epigastrium is pressed exhibits signs of pain. Pulse and respiration accelerated.

℞.—Blister over epigastric region, and sinapisms to extremities.

℞.—James' powder (Pulvis Antimonii Compositus) gr. xxij; calomel gr. xij; opium gr. ij.—Mix. Divide into twelve powders and administer one every two hours.

28th, 11 o'clock A. M. The blister has aroused the nervous system, and the patient is restored to the use of his reason.

℞.—Continue calomel and opium.

℞.—Neutral mixture.

7 o'clock P. M. The action of the blister has been only temporary, and the patient is now stupid, almost comatose. Pulse, 120. Respiration, 22. Pulse is so feeble that it is with difficulty counted. Tongue coated with yellow fur, dry and rough. The surface feels harsh, like the surface of a board. It is evident that the stimulant effect of the blister has vanished, and that the calomel is exerting no beneficial effect.

℞.—Sinapisms to extremities.

℞.—Brandy f℥viij; infusion of Virginia snakeroot f℥viij; sulphate of quinia gr. xv.—Mix. Administer ℥j every half hour.

℞.—Sulph. of quinia gr. v every three hours, up to gr. xx.

29th, 11 o'clock A. M. Lies in a stupor, with mouth and eyes partially open. When aroused by shaking, answers sluggishly and in a few moments relapses into a stupor. Teeth coated with sordes. Tongue coated with black and light yellow fur, with swollen edges, indented by the teeth; perfectly dry and rough. The surface of the tongue is transversed by several deep cracks. Surface of blister red, raw and dry. The serum which issued from the blister was of a golden color. This patient emits a disagreeable nauseous smell. Has taken 40 grs. of sulph. of quinia.

℞.—Continue brandy, infusion of Virginia snakeroot, and sulphate of quinia.

2 o'clock P. M. Examination of Blood.

Blood coagulated slowly.
Serum of a deep golden color.
Nitric acid showed that this color was due to the presence of bile.
Reaction of serum, alkaline.

	Specific gravity of blood	1040
	" " serum	1022

Water.

	In 1000 parts of blood	833.449
	" " serum	912.386
(1)	" " liquor sanguinis	910.798
(2)	" " " "	875.813

Solid Matters.

	In 1000 parts of blood	166.551
	" " serum	87.614
(1)	" " liquor sanguinis	89.203
(2)	" " " "	124.187
	In serum of 1000 parts of blood	80.033

Fixed Saline Constituents.

	In 1000 parts of blood	6.314
	" " serum	6.620
(2)	" " liquor sanguinis	8.759
	" " dried blood-corpuscles	6.595
	" " moist blood-corpuscles	1.648
	" " dried residue of blood	37.909
	" " " " serum	75.558
	In serum of 1000 parts of blood	5.747

1000 parts of Blood contained—

Water			833.449
Dried blood-corpuscles	85.968	Dried organic residue	84.400
		Fixed saline constituents	0.567
Fibrin			1.450
Albumen, extractive and coloring matters	80.033	Dried organic residue	74.186
		Fixed saline constituents	5.747

1000 parts of Blood contained—

Moist blood-corpuscles	343.872	Water	258.804
		Dried organic residue	84.400
		Fixed saline constituents	0.567
Liquor sanguinis	656.128	Water	574.646
		Albumen, extractive and coloring matters	74.185
		Fixed saline constituents	5.747
		Fibrin	1.450

1000 parts of Moist Blood-Corpuscles contained—

Water	752.646
Dried organic residue	245.239
Fixed saline constituents	1.648

(1) 1000 parts of Liquor Sanguinis contained—

Water	910.797
Albumen, extractive and coloring matters	80.996
Fixed saline constituents	1.587
Fibrin	6.620

(2) 1000 parts of Liquor Sanguinis contained—

Water	875.813
Albumen, extractive and coloring matters	113.064
Fixed saline constituents	8.758
Fibrin	2.209

7½ o'clock P. M. The stimulants and sulphate of quinia have excited the chemical changes and aroused the nervous system, and the patient is now restored to the exercise of his intellect. He is still, however, very weak, and has a great tendency to sleep. Pulse, 98; respiration 18, full. Temperature of atmosphere, 80° F.; temp. of hand, 98°. Skin of head and trunk feels a little warmer than normal, and is slightly moist. Tongue presents the same dry, coated, rough appearance. Reaction of saliva decidedly acid.

℞.—Mustard to extremities. Continue brandy, infusion of Virginia snakeroot, and sulphate of quinia. Diet: milk punch, brandy, and arrowroot.

30th, 2 o'clock P. M. His intellect is clear, and there is less tendency to sleep, and he appears to be decidedly better. Pulse 80, much fuller; respiration, 14. Temperature of atmosphere, 71° F.; temp. of hand, 97°. Tongue is still very dry, rough, and black in the centre; it appears, however, when pressed with the finger, to be somewhat softer.

Urine passed this morning high colored. Urine passed during the night several shades lighter, and of the usual color. Reaction decidedly acid. Specific gravity of urine passed this morning, 1016. Owing to the weakness of the patient, the whole amount was not collected. Amount of uric acid in 1000 parts of urine, 0.59. Reaction of saliva, acid.

℞.—Continue stimulants, sulphate of quinia, and nutritious diet.

October 1, 1 o'clock P. M. Says that he feels better, and is hungry. Pulse, 90; respiration, 20. Temperature of atmosphere, 73° F.; temp. of hand, 98.75°; temp. under tongue, 101°. Complexion very sallow. Tongue slightly moister, cleaner, and softer.

Urine of a deep orange color, clear, and limpid; reaction acid; sp. gr., 1016. Uric acid in 1000 parts of urine, 0.659.

2d, 1 o'clock P. M. The expression of the countenance is better, and the surface of the blister looks much better. Tongue still

coated with dark-brown fur, but moister and softer. The sordes around his teeth, and the disagreeable smell, are rapidly disappearing. Abdomen tumid. Pulse, 88; respiration, 18. Temperature of atmosphere, 77° F.; temp. of hand, 102°. Was able to get up and walk across the ward this morning.

℞.—Continue brandy and snakeroot tea, and sulphate of quinia; tablespoonful every three hours.

Urine orange colored; sp. gr., 1016. Uric acid in 1000 parts of urine, 0.511. Reaction of saliva decidedly acid. As in the former examinations, there was scarcely sufficient saliva to moisten the test paper.

3d, 1 o'clock P. M. Has apparently taken a change for the worse. Inclined to stupor; goes to sleep whilst conversing; countenance anxious and distressed. This inclination to stupor may be the effect of the brandy and sulphate of quinia. During the last four days has taken about one hundred grains of the sulphate of quinia.

℞.—Stop stimulants and sulphate of quinia.

Pulse, 94; respiration, 18. Temperature of atmosphere, 77° F.; temp. of hand, 102.5°. Bowels are costive.

℞.—Citrate of magnesia and soda powders.

Urine of yesterday deposited a heavy light-yellow deposit. Urine just passed light orange colored, limpid; reaction acid; sp. gr., 1006. Uric acid in 1000 parts of urine, 02.38.

4th, 2 o'clock P. M. Medicine operated slightly. Pulse, 94.

℞.—Infusion of Virginia snakeroot.

℞.—Tincture of muriate of iron ♏x, three times a day.

5th, 2 o'clock P. M. Anxious expression of countenance; bowels costive; abdomen tumid. Tongue a little softer and cleaner, but still much drier, harder, and rougher than normal. Notwithstanding the slight improvement of his strength, there is still an almost complete absence of the secretions of the mucous membrane of the mouth. Pulse, 90; respiration, 15. Temperature of atmosphere, 74° F.; temp. of hand, 96°; temp. under tongue, 103°.

The temperature of the extremities is two degrees below, whilst the temperature of the trunk is four degrees above, that of health. Accompanying this loss of animal heat in the extremities, and exaltation in the trunk, there is a rapid, feeble pulse, normal respiration, dry, harsh skin, dry mouth, feeble digestion, torpid bowels, sluggish intellect, and feeble forces. These facts, taken in connection with the analysis of the blood, show that the malarial poison has produced profound alterations in the constituents of the blood,

interfered with the formation of the secretions, interfered with the chemical changes of the blood and nutritive fluids, interfered with the development and correlation of the physical, vital, and nervous forces.

The dry, harsh tongue; the scanty, acid secretions of the mucous membrane of the mouth; the torpor of the bowels; the high-colored, acid urine; the dry, harsh skin; the feeble circulation in the capillaries of the extremities; the elevation of the temperature of the trunk; the loss of harmony between the actions of the circulatory and respiratory systems—all point to profound disturbances in the domain over which the sympathetic system presides. The sluggish intellect indicates derangement of the cerebro-spinal system. The feeble forces point to derangements in both the sympathetic and cerebro-spinal systems.

The fact that the temperature of the extremities is but two degrees below the normal standard, whilst that of the trunk is several degrees above the normal standard, affords evidence that the chemical changes of the organs, tissues, and blood are sufficient in quantity to work the machinery with the accustomed vigor. But the machinery is not worked with the accustomed vigor; the patient is weak, and unable to accomplish any mechanical effort at all corresponding to the chemical changes of the elements and solids. The forces are generated, but they are not properly applied, or they are not properly related to each other, or they are not generated in the right position or in the proper apparatus. If muscular force is generated by the chemical changes of the elements composing the muscular tissue, and if the nervous force is generated by the chemical changes of the elements composing the nervous and muscular systems, if the transmission of the nervous excitement is dependent upon chemical changes in the elements of the nerves along which the excitement passes, it is evident that whatever interferes with those chemical changes must be attended by either an exaltation or depression or aberration of muscular and nervous force. If the colored blood-corpuscles, taken collectively, be an immense gland which elaborates the materials for the nutrition and development of the forces of the muscular and nervous systems, then their destruction by the malarial poison would in great measure account for the disturbances in the muscular and nervous systems.

Important questions present themselves: Do the disturbances in the sympathetic and cerebro-spinal systems arise from a direct action of the malarial poison upon one or the other of these sys-

tems? Do the alterations in the secretions and excretions, and in the amount and character of the chemical changes and physical forces, depend upon the direct action of the malarial poison upon the organs, elaborating the secretions and separating the excretions, and preparing the materials destined to form the elements of the tissues and undergo those chemical changes, by which all the forces are generated? Or, do the alterations of the secretions and excretions depend upon alterations of the blood, which is the great reservoir of materials for chemical change and nutrition? Or, do they depend upon a deficiency, or excess, or perversion, of nervous influence, which is supposed to influence secretion? A correct solution of these problems is impossible, in the present state of medical science, because the ultimate facts are wanting.

Specific gravity of urine, 1006; reaction alkaline after standing twenty-four hours. Amount of uric acid in 1000 parts of urine, 0.078.

℞.—Stop tincture of muriate of iron immediately. At 10 o'clock P. M. this night (twelve hours afterwards) administer calomel gr. x, followed by castor oil in four hours. If he is weakened by the action of the medicine, administer stimulants freely.

6th, 1 o'clock P. M. Medicine operated four times, and has produced great exhaustion. Tongue clean and much moister and softer; the moisture of the tongue, however, varies greatly. This morning at 10 o'clock A. M. it was moist and soft; at 12 o'clock M. it was almost entirely dry, and now it is moist. Pulse 100, very weak; feels like the vibrations of a spider's thread. It requires time and care to find the pulse, and much more time and care to ascertain correctly its number of vibrations. It appears that I have made a mistake in giving the calomel and oil. His system is so much exhausted that it is doubtful whether it will rally.

℞.—Brandy and infusion of Virginia snakeroot; milk punch.

℞.—Compound tincture of gentian f℥j; compound tincture of bark f℥j. Mix, and administer three times a day in a wineglassful of infusion of snakeroot.

℞.—Chlorate of potassa ℥j; water f℥viij. Dissolve, and administer during the twenty-four hours. Diet, mutton soup, boiled rice, brandy, arrowroot, and milk punch.

7th, 3 o'clock P. M. Looks better. The anxious expression of his countenance is removed, his intellect is brighter, and his spirits better. Tongue softer and moister than it has been during the sickness. Pulse 92, watery and feeble, but stronger than yester-

day; respirations, 13. Temperature of atmosphere, 70.5° F.; temp. of hand, 97°; temp. under tongue, 103°.

℞.—Continue medicine and diet.

℞.—Spirits of turpentine, 10 drops, four times a day.

8th, 2½ o'clock P. M. Says that he feels very weak. Tongue moister and softer. Pulse 96, feeble and watery; respirations, 16. Temperature of atmosphere, 72.5° F.; temp. of hand, 97.25°; temp. under tongue, 102.5°. Has not had a movement of the bowels since the action of the calomel.

℞.—Phosphate of soda ℥iij; water f℥v. Dissolve, and administer in two doses. Continue tonics, stimulants, and nutritious diet.

9th, 2 o'clock P. M. Complains of great weakness. His sallow complexion, anemic lips and gums, feeble pulse, and feeble forces, demonstrate that his feelings are founded in the effects of the malarial poison. Pulse, 92; respirations, 16. Temperature of atmosphere, 73° F.; temp. of hand, 86°; temp. under tongue, 103°. The hand in which the thermometer was placed was carefully surrounded with the non-conducting blanket. Notwithstanding this favorable arrangement for the accumulation and manifestation of animal heat, the thermometer during the period of one hour indicated a temperature of 86°, which is twelve degrees below the normal standard. The temperature of his trunk, on the other hand, is four degrees above the normal standard and seventeen degrees above that of the extremities. Here we have a disturbance of the temperature analogous to that of the well-marked chill of malarial fever, and yet the patient does not complain of the sensation of cold, and there is no shivering of the muscles, and the respiration is normal in frequency, and the violent action of the respiratory muscles characteristic of a well-marked chill is absent. The feeble pulse, on the other hand, attended with elevation of the temperature of the trunk and depression of the temperature of the extremities, corresponds with the phenomena of a well-marked chill, and indicates deficient circulation of blood and arrest of chemical action in the capillaries of the extremities, and, at the same time, accumulation of blood and increase of chemical change in the capillaries and bloodvessels of the large organs of the trunk. The increased heat of the trunk during the cold stage may arise, in part, from the chemical changes in the blood corpuscles, resulting in their destruction, and in the liver, resulting in the alterations of its secretions and nutritive fluids. The heat thus generated by the destruction of the blood-corpuscles, by the alterations of the other elements of

the blood, and by the alterations of the secretions and nutritive fluids of the liver, induced by the presence of an extraneous poisonous body, would be generated in the wrong position, and by a wrong collocation, action, and reaction of elements, and would, so far from adding to the forces, produce derangement and interfere with the carefully-adjusted balance of the forces. It is a well-established truth in physiology that vital phenomena are manifested by matter having a definite chemical and physical constitution, and whatever alters the arrangement of the matter destroys the essential conditions of the manifestation of the vital phenomena. The study and investigation of man should be, not what are the essences of the physical, chemical, and vital forces, but what are the essential conditions and laws of their existence and manifestation.

Whilst the low temperature of the extremities, accompanied by a feeble rapid pulse, is a very dangerous symptom, still the condition of the patient would be much worse if the temperature of the trunk corresponded with that of the extremities. A definite temperature of the trunk is absolutely essential to the maintenance of life in man. An elevation or depression of the temperature of the great organs of the trunk, of only a few degrees, is attended with death; because this fixed temperature is one of the essential conditions for the conduction of those chemical processes by which the forces are generated; and by which, under the guidance of the vital principle, poisonous compounds are removed and new matter elevated into a state of force, and rendered suitable for the habitation of the vital principle, by the action of the forces of the sun through the apparatus of the vegetable kingdom, is introduced into the position of that chemically altered and removed; and by which that constitution of matter is preserved, which is indispensable for the existence of the vital principle, and the manifestation of vital phenomena, by the correlation of the chemical and physical forces, acting under the guidance of the vital principle, upon and through special apparatus. Whilst even a moderate elevation or depression of the temperature of the great organs of the trunk is necessarily attended by the generation of abnormal compounds, or by a complete arrest of the chemical and physical and nervous actions; the elevation or depression, even to a great extent, of the temperature of the extremities is not, on the other hand, attended by such serious consequences, because these parts of the body are destined to act as mere servants to the spiritual nature, as mere organs of

locomotion and mechanical action, and not as chemical laboratories for the preparation of the nutritive elements, and of the matters destined for the development of the forces. Nevertheless, as the forces which work the muscular system are developed by the chemical changes of the structures of the muscles, and of the compounds and elements of the surrounding blood; and as the excitement and transmission of the nervous force to the muscular system is the result of the chemical changes of the elements of the nerves (and probably of the muscles), it is evident that a reduction or elevation to any great extent, of the temperature of the extremities, must also, but in a much smaller degree, interfere with the chemical changes going on in those muscles and with the correlation of the chemical, physical, and nervous forces.

The development of the muscular and nervous forces depends upon the constitution of the muscular and nervous apparatus, and a free supply of oxygen (*the great agent of chemical change*), *and of the nutritive and force-generating elements of the blood.* In the case before us, the muscular and nervous systems appear to be normal in constitution, whilst the blood and oxygen are wanting.

To restore the action of the muscular and nervous systems, and prevent the generation of noxious compounds by the reduction of temperature, we must restore the circulation of blood, and the distribution of oxygen. Acting upon these principles, I endeavored to arouse the circulatory, respiratory, and nervous systems, by sinapisms.

Applied large mustard plasters to the extremities.

In ten minutes after the application of the mustard, the temperature of his extremities had risen six degrees (from 86° to 92°), and his pulse had become fuller, and increased eight beats (from 92 to 100 beats).

In half an hour after the application of the mustards, the temperature of the extremities had risen sixteen degrees, from 86° to 102°, and the pulse had increased 12 beats to the minute. During these changes the respiration and the temperature of the trunk have remained uniform. The elevation of the temperature from 86° to 92°, during the first ten minutes, was more rapid than the subsequent elevation during the succeeding twenty minutes, from 92° to 102°. After reaching this temperature, the thermometer indicated a stationary temperature both in the hand and under the tongue, and at 8 o'clock P. M., five hours after these observations, the pulse

was 94; respiration 16. Temperature of atmosphere, 70° F.; temp. of hand, 102°; temp. under tongue, 103°.

Here we see that although the frequency of the pulse has been reduced, and it has returned back to within two beats of what it was when the temperature of the hand was only 86°, still the temperature of the hand is 102°. The pulse has increased in volume, and hence the increased elevation of temperature is due to the increased circulation of blood. It is evident that the action of the mustard has not been evanescent. The following table will exhibit in a clear light the changes induced by the revulsives.

	Before the application of the sinapisms.	10 minutes after the application of the sinapisms.	30 minutes after the application of the sinapisms.	5 hours after the application of the sinapisms.
Pulse . . .	92	100	104	94
Respiration . .	16	16	16	16
Temp. of atmosphere	73°	73°	72°	71°
Temp. of hand . .	86	92	102	102
Temp. under tongue .	103	103	103.2	103

The restoration of the circulation and chemical changes in the capillaries of the extremities, was attended by a subsidence of the twitching of the tendons, by a disappearance, in a great measure, of the feelings of exhaustion, by an increase of the secretions of the mucous membrane of the mouth, tongue, and fauces, and by an increase of muscular and nervous force.

The patient says that the mustards have made him feel much stronger.

In this experiment the volatile, stimulant oil of mustard, has not simply called forth the nervous force existing in the system, but has produced a permanent exaltation of the nervous and physical forces.

This was accomplished by the stimulant principle of the mustard, and its distribution, by the bloodvessels, to all parts of the sympathetic and cerebro-spinal nervous systems. The action of the heart was thus increased, and the absorption and distribution of oxygen, promoted by an acceleration of the general and capillary circulation.

Before the action of the stimulant, the chemical changes in the capillaries of the extremities were slow and small, because the circulation in the capillaries of the extremities was sluggish, and the amount of oyxgen and blood supplied to the muscles and nerves of the extremities, insufficient to sustain vigorous chemical changes.

When the circulation was aroused, the chemical actions in the

extremities were correspondingly increased, because the elements of these changes were presented in abundance, and with rapidity. As the muscular and nervous forces depend upon chemical change, the excitation of the chemical changes were necessarily attended by an increase of muscular and nervous force.

Thus, the increased supply and distribution of the elements of chemical change, led to an increase of nervous and physical force, and this nervous and physical force, in turn, led to a still farther excitement of the machinery devoted to the absorption and distribution of the oxygen, the great element of chemical change. Hence, the excitement was permanent.

℞.—Carbonate of ammonia gr. x, every four hours.

℞.—Oil of turpentine ♏x, every three hours. Continue stimulants, tonics, and nutritious diet.

10th. Much better. Temperature of the extremities corresponds with that of the trunk.

Urine has a strong smell of turpentine. Amount passed during the last eighteen hours, 12,168 grains; sp. gr. 1014. Deep orange color, inclining to red; reaction decidedly acid. Slight turbidity, but no deposit. 12,168 grs. of urine passed during twenty-four hours contained urea, 209.520 grs.; uric acid, 12.60 grs. 1000 parts of urine contained urea, 17,212; uric acid, 1,035.

4 o'clock P. M. Appetite good; tongue moist. Pulse, 100; much stronger than yesterday, before the application of the mustards. Respiration, 16. Temperature of atmosphere, 69.5° F.; temp. of hand, 101.°; temp. under tongue, 102.5°.

Urine high colored, reddish-brown; sp. gr., 1016; reaction decidedly acid, clear, limpid. Amount passed during the last five hours, 4,562 grs.

℞.—Continue.

11th. Continues to improve. Is able to walk about the ward.

℞.—Citrate of iron gr. ij; sulph. of quinia gr. iij.—Mix. Administer three times a day.

℞.—Continue stimulants, tonics, and nutritious diet, oysters, soft boiled eggs, milk punch, &c.

17th. Has continued to improve, and is now able to walk in the hospital grounds. He is still, however, pale, sallow, and very weak. Pulse 76, full and strong; perspiration, 14. Temperature of atmosphere, 67° F.; temp. of hand, 97.25°; temp. under tongue, 100.°; reaction of saliva very slightly acid. During his sickness it has been decidedly acid.

I have been informed, upon reliable authority, that one week after the admission of this patient into the hospital, his captain weighed anchor and sailed for New York. The crew consisted of the men whom he had compelled to sleep on board the vessel, lying along the low, marshy shore. Several of the crew were unwell at the time of sailing. Before getting well out to sea, the captain and the whole crew were taken sick. In a few days there was not a man with strength to navigate the ship. Fortunately, a small vessel perceived their signals of distress, and towed them into Darien. Before reaching this port, the captain and five out of seven of the crew had died. There were but two remaining of eight, and these were extremely ill. The severity of the disease, in this case, resembles the accounts of African fever. From the report of this case, which came under our own observation, it is evident that any carelessness or neglect would have been attended by a fatal termination. Notwithstanding the administration of the most active tonics, and of the most nutritious diet, this patient exhibited for a great length of time the effects of the bilious remittent fever, in his pale, sallow, anemic countenance, pale lips and gums, and tottering gait.

Case illustrating the Pulse, Respiration, and Animal Temperature, and the Effects of Purgatives, in Congestive Fever.

American seaman; height 5 feet 9 inches; weight 160 pounds; stout, well built; large chest, brown hair, bronzed complexion, bilious temperament; age 45. Has been in Savannah three weeks. Was taken with a chill October 8, at 12 o'clock M., which lasted one hour, and was followed by fever, which continued, without remission, for eight hours. On the 9th inst. (the next day) had no chill.

October 10, 1857, 1½ o'clock P. M. Entered the hospital this morning at 10 o'clock. At 12 o'clock M. the chill came on. The chill was well marked; rapid, small pulse; rapid thoracic respiration; shivering, quivering muscles; high temperature of the trunk, and low temperature of the extremities. The chill lasted one hour and twenty minutes. Now (1½ o'clock P. M.) the shivering has ceased, and the circulation in the capillaries is more vigorous, and the difference between the temperature of the trunk and extremities less. Pulse 130, full; respiration 46, thoracic. Temperature of atmosphere, 68.5° F.; temp. of hand, 100°; temp. under tongue, 106°. The difference of temperature between the trunk and extremities

shows that the relation between the general and capillary circulations has not as yet been completely established.

Tongue perfectly dry, and feels rough under the finger, like sand-paper. Those portions which are not coated by yellow fur are of a bright red color. Pressure over epigastric region causes some pain. Has pain in his chest, and a very bad cough. Says that he has suffered with a cough for one month, and three weeks ago "spit blood." Complains of "pain in his bones." Has taken no medicine.

℞.—Calomel gr. xij; sulphate of quinia gr. vj. Mix, and administer immediately, and follow with castor oil in four hours.

℞.—Neutral mixture. As soon as fever remits, give gr. v of the sulphate of quinia every three hours, up to gr. xxv.

8 o'clock P. M. Febrile excitement is declining. Skin in a good perspiration. Has no pain anywhere, and is very comfortable.

℞.—Commence with sulphate of quinia immediately.

11th, 11 o'clock A. M. Severe vomiting commenced last night at 11 o'clock P. M., and has continued unchecked up to 4 o'clock A. M., when the nurse administered a mixture of milk, lime-water, and acetate of morphia, which has in a great measure checked the vomiting. Twenty-six grains of the sulphate of quinia have been administered since 8 o'clock P. M.; only eleven grains have been retained. Says that the calomel and oil operated powerfully, and he was upon the night-chair almost the whole night. The discharges appear to have been serous fluid colored with bile. Says that he has always been greatly affected by cathartics; even the smallest doses have produced violent purgation, followed by great exhaustion. I was not aware of this idiosyncrasy when the medicine was administered. Now his extremities are covered with a cold, clammy sweat, and he is completely exhausted. During the action of the medicine he was almost senseless from the great prostration consequent upon the violent purgation and vomiting. Pulse, 94; respiration, 22. Temperature of atmosphere, 71° F.; temp. of hand, 79°; temp. under tongue, 97°.

The temperature of the extremities is nineteen degrees below the normal standard, whilst the temperature of the trunk is only two degrees below that of health. The pulse is accelerated thirty-four beats to the minute; the respiration is but slightly accelerated. The temperature of the extremities and trunk does not correspond to the increased action of the circulation and respiration.

This remarkable reduction of the temperature of the extremities and trunk is attended by a complete prostration of the forces.

The respiration is sufficiently rapid and full to introduce large quantities of the great element of change—oxygen; and the action of the heart is sufficiently rapid, but not sufficiently powerful, to distribute the elements of nutrition and chemical change in the capillaries of the extremities. The pulse is feeble, and the circulation in the capillaries of the extremities exceedingly sluggish. Here we have a condition of the extremities resembling that of a well-marked chill. The elevation of the temperature of the trunk, and the shivering and quivering of the muscles, characteristic of the well-marked chill, however, are absent. The temperature of the trunk is absolutely lower than that of health, notwithstanding the acceleration of the respiration and circulation. This disturbance of chemical action, this disturbance of the physical forces, this prostration of the nervous and muscular systems, are, without doubt, due to the simultaneous actions of the purgative and malarial poison. Here we have an instance of vomiting and purgation producing such a disturbance of circulation, respiration, and chemical action, and such a prostration of the muscular and nervous systems, that a simple case of intermittent fever is converted into what is ordinarily called congestive fever.

The phenomena of this patient, during the febrile excitement, were such as warranted the administration of calomel.

Administered stimulants and sulphate of quinia. His stomach is so irritable that it will not retain these medicines. Sinapisms have been applied to the extremities; bottles of hot water applied to feet and legs. The mustards have been very slow in their action, producing but little or no coloration of the skin after the lapse of half an hour. They remained on for three-quarters of an hour before the skin was decidedly reddened. After the action of the mustards for three-quarters of an hour, the temperature of his hand is 88°, and that under the tongue 97.75°. The temperature of the extremities has risen nine degrees, whilst that of the trunk has risen only three-fourths of a degree. The action of the stimulant principle of the mustard has been to excite the general and capillary circulation, through the sympathetic nervous system. This excitement has been attended by a more rapid distribution of the elements of nutrition and chemical change. These increased chemical changes have been attended by an increased generation of the physical, muscular, and nervous forces. The increase of chemical change, and the increase of physical force, are attended by a rectification of the aberrated phenomena of the sympathetic and cerebro-

spinal nervous systems. The restlessness, the feeling of complete exhaustion and prostration, and the vomiting, have in a great measure disappeared. The stomach is now able to retain stimulants and sulphate of quinia.

℞.—Continue sulphate of quinia gr. v, every three hours, up to gr. xl. If the stomach rejects the sulphate of quinia, administer ten grains by the rectum, combined with starch and tincture of opium, every three hours. Continue stimulants and infusion of Virginia snakeroot.

Urine of a brownish-red color; sp. gr. 1014; reaction decidedly acid, even after standing forty-eight hours. When treated with hydrochloric acid, the urine was changed to an almost black color. After standing forty-eight hours there was no deposit. Uric acid in 1000 parts of urine, 0.0197. It was impossible, on account of the severe purgation, to determine the whole amount of urine excreted.

12th, 12 o'clock M. Says that he rested well during the night, and feels better, but is still very weak. Has vomited three times this morning. The cold, clammy feeling of his skin has disappeared, and the patient appears to be decidedly better. Tongue red at tip, and pointed; papillæ enlarged and distinct. Pulse 100, much fuller and stronger than during the state of prostration. Respirations 30, quick, but gentle; does not resemble the full, labored, thoracic respiration of many cases of congestive fever. Temperature of atmosphere, 74° F.; temp. of hand, 100.75°; temp. under tongue, 101.20°. This observation demonstrates that the increased distribution of blood and oxygen has been attended by a decided elevation of temperature. Whenever there is an imperfect capillary circulation, whenever there is a deficiency of the elements of nutrition and chemical change, then will we have feeble forces and aberration of muscular and nervous action. The temperature, the muscular force and the nervous force, depend absolutely upon the chemical changes of the elements of the living organism, which have been elevated into a state of force, by the action of the forces of the sun upon special apparatus, or rather upon a great laboratory, the vegetable kingdom.

The rapidity of the chemical changes, which develop the forces of the machinery, depends first, upon the supply and distribution of materials capable of entering into the constitution of the organs, tissues, and apparatus; secondly, upon the supply and distribution of materials capable of undergoing chemical change, within and

around the machinery, and thus generate the forces in positions advantageous for their application; thirdly, upon the replacement of the chemically altered matter which once formed part of the apparatus (machinery), by new matter; fourthly, upon the removal of the products of chemical change, which derange chemical action, first, by occupying positions in the apparatus which should be occupied by matter in a state of force, and not by matter which has lost the amount of force originally received from the sun; secondly, by inducing chemical changes in the wrong position in parts of the organism, where the forces resulting from these chemical changes cannot be applied; and, thirdly, by a direct poisonous effect upon the organs, tissues, and apparatus, especially upon the nervous system, which keeps up a communication between all parts of the system, and controls, in a great measure, the distribution of the elements of nutrition and chemical change, by controlling the action of the respiratory and circulatory apparatus.

The supply and distribution of the materials of nutrition and chemical change depend, first, upon the perfection and action of the vegetable apparatus, and secondly, upon the perfection and action of the animal digestive, circulatory, and respiratory apparatus, related and co-ordinated by the nervous system.

The study of the animal kingdom, as a whole, demonstrates that the perfection and action of the respiratory and circulatory systems may be taken as an index of, not only the physical and chemical changes of the organized fluids and solids, but also of the development and perfection of the organs, and tissues, and apparatus, and of the activity and intelligence of animals. The action of the respiratory and circulatory apparatus, and the co-ordination of this action with the action and wants of the muscular and nervous systems, and of all these organs, and tissues, and apparatus, are guided by the nervous system in which a special force is generated; excited and guided by nervous force, but not carried on by nervous force, independent of chemical change. Chemical change in the organs and apparatus, and chemical change in the nervous system, is the source not only of heat, but of muscular and nervous force, and of all the forces generated in the animal economy.

The generation of any force—vital, nervous, chemical, or physical—in the animal economy, independent of antecedent force, would destroy the great law upon which the stability of the universe rests, that force is indestructible—would destroy the great law that action and reaction are equal.

All the forces in the animal economy are generated by chemical

action. The various organs and apparatus are simply arrangements for the preparation of materials suitable for chemical change, and for the application of the forces generated by chemical change.

According to this view, the action of the vital force, like that of the intelligence, is limited to a guidance and direction of the forces with which the Creator has endowed all matter. The action of the vital principle upon matter, like that of the intelligence, does not consist, either in a *creation* of matter or in a *direct movement of matter, independent of the forces of matter,* but in the *mere guidance and application,* of the forces of matter, so that definite forms are developed from formless matter, and definite results accomplished.

According to this view, the vital principle and the intelligence, cannot create force, any more than they can create matter. Their influence is limited to an excitement and application of the forces of matter.

We judge of the influence of one just as we judge of the influence of the other. The complicated machine points to the existence of an intelligence distinct from matter, which has so applied the forces of one portion of matter, that another portion has been moulded into definite shapes and formed into definite apparatus, capable of accomplishing definite results when acted upon by forces generated and applied in the right manner. We infer the existence of the intellect by the results of its application of the forces of matter. In precisely the same manner do we infer the existence of the vital principle. The vital principle directs the forces, resulting from the chemical changes of one part of matter, in such a manner that surrounding matter is fashioned, moulded into definite forms and apparatus, destined to accomplish definite results. This apparatus cannot be worked by the vital principle, independent of chemical change, any more than a watch will run, or any machine will accomplish various mechanical effects, without a supply of exterior force, or a steam engine accomplish mechanical effects, without the development of force by the chemical changes of matter, which has been elevated into a state of force (placed in a state capable of undergoing chemical change) by the forces of the sun.

The development and structure of the vegetable kingdom, the development and structure and actions of the most simply constructed animals, the appearance of the nervous system in the animal kingdom and in the fœtus of the higher animals subsequently to the grouping of the atoms of formless matter into definite forms and apparatus, before the formation of nerve-cells and nervous systems, demonstrate unequivocally, conclusively,

and absolutely, that development, nutrition and the direction of the forces of one part of matter, to the fashioning of another part, are under the guidance of the vital principle; demonstrate unequivocally, conclusively, and absolutely, that the nervous system itself is developed and its perfection maintained under the guidance of the vital principle. The nervous system is the last and best work of the forces of matter directed by the vital force, and is destined to connect together and influence the various organs and apparatus, and is destined to regulate secretion and excretion, and the consequent development of force; and is destined to excite and control the actions of the dynamic muscular apparatus, not by the possession and emission of a peculiar force generated *de novo*, but rather by a modification of physical force generated by the mutual chemical reactions of the elements of the blood and nervous system. The truth of this proposition is conclusively demonstrated by the fact that an arrest of chemical action is immediately attended by an arrest of nervous and muscular force.

During the last twenty-four hours, has taken and retained 25 grs. of the sulphate of quinia. ℞.—Continue stimulants. Diet, wine whey and arrowroot.

Urine orange-colored; sp. gr. 1020; reaction decidedly acid, and remained so longer than sixty hours. After standing fifty hours there was a slight deposit of epithelial cells, mucous corpuscles and cylindrical casts of the tubuli uriniferi. Amount of urine collected during the last twenty-four hours, 6120 grs. The patient affirms that this was the whole amount passed during the last twenty-four hours. When the urine was evaporated to the consistence of a syrup and treated with nitric acid, there was a powerful effervescence, and the urine assumed a dirty-brownish yellow color, and the nitrate of urea presented a brownish-black color, and imperfect crystallization. When the urine was concentrated by evaporation it assumed a brownish-black color. When the unconcentrated urine was treated with hydrochloric acid, it assumed a dark-mahogany, almost black color. The solid matters of the urine appeared to consist principally of the coloring matters.

	6120 grains of urine, collected during 24 hours, contained	1000 parts of urine contained
	Grains.	
Urea	41.960	6.822
Uric acid	0.060	0.009
Fixed saline constituents	43.800	7.156

This examination of the urine shows that during the reduction of the temperature of the body and exhaustion of the forces, the urine was excreted in less amount, and altered in quality. Here we have a demonstration of the previous propositions, that animal temperature and muscular and nervous force are the results of chemical change, and that the reduction of temperature is attended by the generation of chemical compounds different from those of health, and that the malarial poison acts by inducing chemical changes in the elements of the blood and organs, different from the chemical changes of health.

The fact that the chemical changes of the nutritive and force elements in the capillaries of the muscles and nerves and bones of the extremities and surface of the trunk and head were very small, and the fact that the blood was congested in the bloodvessels of the trunk, render it probable that the peculiar coloring matter of the urine was derived from the disintegrated blood-corpuscles.

8 o'clock P. M. Says that he feels very weak. Has been vomiting bile. Three hours ago six cut cups were applied over the epigastric region, without any arrest of the vomiting. Tongue very red at tip, and the surface is dry and rough, like sand-paper. The patient appears to be completely prostrated. Pulse 104.

℞.—Apply a blister, six inches by six inches, immediately over the epigastric region, and as soon as it blisters, if the vomiting is not arrested, remove the cuticle, and sprinkle over the raw surface one grain of the acetate of morphia. Stop all stimulants and administer internally small fragments of ice and milk and lime-water and acetate of morphia.

Urine, orange colored; sp. gr. 1016. Amount passed during the last eight hours, 10,160 grs.; calculated amount of urine for twenty-four hours, 30,480 grs.; reaction decidedly acid. Here we have a decided increase of the urine..

13th, 1 o'clock P. M. Says that he feels much better. Pulse 86, fuller and stronger; respirations 28. Temperature of atmosphere, 76° F.; temp. of hand, 91°; temp. under tongue, 98.5. Surface of the body in a profuse perspiration, which feels cold to the hand. The temperature of the extremities does not correspond with the increased circulation and respiration. The blister has drawn well, and the serum is of a light-yellow color, and not the golden color of many cases of remittent and congestive fever. The blister and the acetate of morphia and ice have completely arrested the obstinate and violent vomiting.

℞.—Sulphate of quinia gr. xv; tincture of opium ♏xx: starch f℥iv. Mix and administer immediately as an enema, and repeat in the course of four hours. Diet, arrowroot and chicken soup.

Amount of urine passed during the last fifteen hours 8112 grs. Color only a shade darker than normal; sp. gr. 1014; reaction decidedly acid after standing thirty hours. No deposit after standing thirty hours.

	8112 grains of urine, excreted during 15 hours, contained	12,979 grains of urine, calculated for 24 hours, contained	1000 parts of urine contained
	Grains.	Grains.	
Urea	159.080	254.528	19.594
Uric acid	2.000	3.200	0.256
Fixed saline constituents .	16.800	26.880	2.071

During the last three days the patient has been able to retain little or no nourishment, so that this is the urine of starvation.

14th, 11 o'clock A. M. Much better; dressed and walking about the ward. Pulse 72, full and strong; respirations, 22. Temperature of atmosphere, 78.5° F.; temp. of hand, 96.75°; temp. under tongue, 98°. Skin feels normal. The cold, clammy sweat has disappeared. Tongue clean, but redder than normal. Although the vomiting has almost entirely disappeared, still the stomach is unable to retain the sulphate of quinia.

℞.—Repeat the enema of sulph. of quinia. Diet, wine whey, soft boiled eggs, and arrowroot.

15th. Continues to improve. Pulse, 64; respirations, 24. Temperature of atmosphere, 74° F.; temp. of hand, 97.75°; temp. under tongue, 98.33°. Tongue still quite red, but moist and soft. The amount of urine has greatly increased. During the last twenty hours has passed 30,360 grains of light-yellow urine, which rapidly changes from the acid to the alkaline reaction, and lets fall a yellow deposit.

Sp. gr. of the urine passed during the night . . .	1010 grs.
" " this morning	1014 "
Amount of uric acid passed during the last 10 hours .	28 "

This is at the rate of sixty-seven grains of uric acid during the twenty-four hours. This examination confirms the statement previously made and substantiated in former cases, that, as a general rule, the uric acid is either normal in amount or diminished in the active stages of malarial fever, and increases during convalescence. As in the present case, this

increase of the uric acid may take place even whilst the patient is under the influence of sulphate of quinia.

℞.—Infusion of Virginia snakeroot and sulph. of quinia. Diet, oyster soup, wine whey, and arrowroot.

16th, 1 o'clock P.M. Still very weak, but continues to improve. Tongue not so red, moister and softer. Reaction of saliva alkaline; up to this time it has been decidedly acid. Pulse, 56; respirations, 22. Temperature of atmosphere, 71.5° F.; temp. of hand, 96°; temp. under tongue, 98.75°.

Urine, light straw colored; becomes alkaline and throws down a light-yellow deposit, after standing a few hours. Amount passed during the last twenty-four hours, 29,000 grains; sp. gr. of the urine passed during the evening and night, 1010; sp. gr. of the urine passed this morning, 1005; 1000 parts of the urine passed this morning contained, urea 8.686; uric acid, a trace, a few small crystals; fixed saline constituents, 1.990. This examination shows that the elimination of uric acid has ceased in the course of a few hours.

17th. Has been walking about the hospital grounds. Pulse, 60; respirations, 26. Temperature of atmosphere, 64° F.; temp. of hand, 94.75°; temp. under tongue, 99°. The exercise will account for the acceleration of the pulse and respiration, and the free exposure of the hands to the cool morning air will account for the slight diminution of temperature. Reaction of saliva, acid. The acidity, however, was not so intense as in the paroxysms. Yesterday the reaction of the saliva was alkaline. During the active stages of malarial fever the saliva, according to my observations, is always decidedly acid, whilst during convalescence it is generally alkaline, but may vary from alkaline to slightly acid. This change in the intensity of the acidity of the saliva corresponds, in a general way, with the diminution of acid in the urine.

℞.—Quassia and soda. Full, nutritious diet.

Amount of urine passed during the last twenty-four hours, 21,000 grains; urine passed during the last afternoon, evening, and night, orange-colored; sp. gr., 1014. After standing a few hours the reaction changed from the acid to the alkaline, and a heavy, light-yellow deposit was thrown down. Urine passed this morning of a light straw color; sp. gr., 1004.

19th. Says that he feels as well as he ever did in his life. Has been walking about the hospital grounds. Pulse, 60; respirations, 24. Tongue, skin, and temperature normal. Blister almost entirely

healed. This patient had no return of fever, and was discharged from the hospital a few days after this observation.

Case illustrating the Effects of Purgatives in Malarial Fever—the Relations of the Pulse, Respiration and Temperature of Trunk and Extremities in Congestive Fever—the Formation of Heart Clots in the Latter Stages of Congestive Fever. The Chemical Constitution of the Urine. The Chemical and Physical and Pathological Changes of the Organs.

Irishman, age 28, height 5 feet 7 inches, weight 140 lbs.; dark brown hair, brown eyes, dark complexion. Has been in Savannah nine months. Engineer on steam-tug running up and down the Savannah River. One month ago was discharged from the steam-tug, and commenced "day labor," along the wharves, and at the saw-mill. Habits intemperate. Has been sick one week. Says that "three days ago he took a large dose of castor oil, which operated ten times. On the following day took three blue pills, and yesterday took another dose of castor oil, which has been operating up to the present time."

August 24th, 1857, 1 o'clock P.M. Has just entered the hospital. Skin cool. Tongue coated with yellow fur. Pulse 120. Complains of great weakness. ℞.—Sulphate of quinia gr. xv; infusion of Virginia snakeroot f℥xvj.—Mix. f℥ij every two hours. Diet, gruel.

25th, 12 o'clock M. Complains of great pain in his back. Surface of trunk and extremities cool. Tongue dry at tip and centre, and coated with yellow fur. No tenderness upon pressure of epigastrium. Bowels loose.

℞.—Stop sulph. of quinia and infusion of Virginia snakeroot. ℞.—Calomel gr. xij; James's powder (*pulvis antimonii compositus*) gr. xxij; mix and divide into six powders. Administer one powder every three hours. If the extremities continue cool, apply mustards

26th, 12 o'clock M. During the afternoon of yesterday was very feeble, and at one time was almost pulseless. The nurse administered brandy. This induced reaction. Now skin of trunk and extremities cool and moist. Complexion pale, sallow; lips and gums very pale. Tongue coated with yellow fur, and dry at tip. Pulse small and weak—so feeble that it is with difficulty that it can be felt at all. Pulse, 120; respiration, 22. Temperature of hand, 95.5° F.

℞.—Burnt brandy and infusion of Virginia snakeroot. Apply sinapisms to extremities. Diet, arrowroot and brandy.

8 o'clock P. M. Pulse a little stronger, but still very weak, 112. Surface of trunk and extremities warmer. Tongue cleaning off towards the tip; the clean portion is very red, dry, and glazed. Has no pain, and rests quietly. Appears to be very weak.

℞.—Continue brandy and infusion of Virginia snakeroot.

27th, 12 o'clock M. Pulse 120, larger in volume, but still very feeble, and with difficulty counted; respiration, 24. Skin a little warmer. Temperature of atmosphere, 87.5° F.; temp. of hand, 98°; temp. under tongue, 98.5°. There is a great want of co-ordination between the actions of the circulatory and respiratory systems. Says that he is very weak. His appearance is that of complete exhaustion. Superior portion of tongue coated with dry yellow fur. A lozenge-shaped space of the surface of the tongue, extending for one inch from the tip to the centre, is clean and of a brilliant red color. Teeth coated with sordes. Hands and tongue tremulous. Says that he feels very weak. Has no pain anywhere, and lies quiet.

℞.—Stop the calomel and James's powder. ℞.—Sulph. of quinia gr. ij, every two hours, up to gr. xv. Continue brandy and infusion of snakeroot.

Urine orange colored, several shades higher than in health, but much less highly colored than usual in severe cases of malarial fever. Reaction slightly acid, sp. gr. 1009, *contained as usual in uncomplicated cases of malarial fever, no albumen, and no grape sugar.* Amount of urine collected during the last twenty-four hours, grs. 16,144. The nurse states that this is the whole amount that has been passed.

	16,144 grains of urine, excreted in 24 hours, contained	1000 parts of urine contained
	Grains.	
Water	15,745.336	975.306
Solid matters	398.664	24.674
Urea	170.610	10.499
Uric acid	a trace, scarcely visible	a trace
Extractive and coloring matters . .	203.683	12.560
Fixed saline constituents . . .	24.161	1.496

7 o'clock P. M. Much worse. Pulse 140, feeble; respiration 40, labored, panting. Extremities feel cold. Temperature of hand, 90°. Restless, groans and sighs frequently. Inclined to stupor. Intel-

lect sluggish; when aroused appears to be sensible, but articulates with great difficulty. The heart appears merely to flutter; the sounds are so rapid and feeble that they are counted with difficulty. The circulation in the capillaries is sluggish and feeble. The temperature, the index of the chemical changes of the elements of the solids and fluids, is below the normal standard, and does not correspond with the frequency of the circulation and respiration. No pain upon pressure of epigastrium. Asks for water continually, and complains of much thirst. The nurse has just raised him up to administer brandy; he groans and tosses about the bed, and makes several ineffectual efforts to rise; in a few moments he is quiet and apparently asleep.

This patient died thirty minutes after this observation.

AUTOPSY TWELVE HOURS AFTER DEATH.

Exterior.—Body muscular, with well-developed limbs and prominent chest; trunk and limbs round, and not emaciated. Adipose matter not wasted. Color of muscles when the integument was removed, red and normal. Color of the skin of the superior parts of the corpse, pale, bloodless; color of the skin of the inferior parts of the corpse, of a dark purple. This dark purple color gradually diminished towards the superior parts of the body, and appeared to have been due to the gradual settling of the blood in the capillaries of the most dependent parts towards the close of life, when the general and capillary circulations were feeble. Lips and gums very pale, almost white. Teeth loaded with sordes.

Head.—Dura mater unusually thick and firm, and adherent in several places to the arachnoid membrane. The thickening of the dura mater and the adhesions were of long standing, and were not connected with this attack of malarial fever. Bloodvessels of the dura mater filled with blood.

Arachnoid membrane opalescent, pearl colored, and in many places adherent to the pia mater. These adhesions, like those between the dura mater and arachnoid membrane, were apparently of long standing. Between the arachnoid membrane and pia mater, bloody serum was effused, thus imparting to these membranes (especially the inferior portions from the gravitation of the blood) a red appearance.

Bloodvessels of pia mater were filled with blood. The bloodvessels of those portions of the pia mater which extended into the ventricles of the brain, were also engorged with blood.

The ventricles of the brain contained a small quantity of clear serum.

Structure of cerebrum appeared to be softer than normal. This softening may have been the result of partial decomposition. Bloodvessels in the substance of the brain, distinct, and more engorged with blood than usual.

Structure of cerebellum, medulla oblongata and superior portion of spinal cord, appeared to be normal. Bloodvessels of spinal cord appeared to be more congested with blood than usual.

Chest.—Heart normal in structure; contained several clots of blood, which from their ragged appearance, light-yellow color, and freedom from colored blood-corpuscles, must have been formed before death. Long, fibrous coagula were found in the aorta and vena cava.

Lungs.—Old adhesions in several places, numerous small tubercles were scattered throughout the tissues of the lungs. The tubercles did not appear to have suppurated. During his sickness this patient showed no signs, either in appearance or in action, of the existence of these tubercles.

Superior portions of the lungs (leaving out of view the tubercles) were normal in color and density. The inferior portions were engorged with blood, and the most dependent portions were almost black from the great engorgement of the bloodvessels and capillaries, and when cut resembled in appearance and density portions of liver. The accumulation of blood in the lower portions of the lungs was due to the action of gravity, during the feeble state of the circulation previous to death. The chemical changes of the elements of the blood and organs and tissues had been greatly diminished, previously to death; the physical forces resulting from these chemical changes which propelled the circulatory apparatus, and worked all the machinery, were correspondingly diminished, and the blood gradually obeyed the physical law of gravity, which although constantly acting during health, was counterbalanced by the physical forces developed by the chemical changes of the elements of the organism.

Abdomen.—Liver normal in size, and of a slate color externally, and of a dark bronze color internally. Substance firm. When pressed, the dark yellow, greenish bile flowed out in small quantities from the cut ends of the hepatic ducts. Bloodvessels of the liver appeared to contain more than the normal quantity of blood. Blood of liver dark purplish-brown, and did not change to the

arterial hue when exposed to the action of the oxygen of the atmosphere.

The liver contained animal starch, but no hepatic sugar.

Under the microscope the cells of the liver appeared normal, with the exception that many of them contained more oil-globules than usual.

The gall-bladder was filled with bile, which was of a dark brownish-green when seen in mass, and of a gamboge color when viewed in thin layers. The surface of the gall-bladder was of this gamboge color, from the endosmosis of the bile, probably after death.

Spleen enlarged; color dark slate, two shades darker than the liver. Tissues of spleen softened; partially disorganized. When the organ was pressed gently between the fingers it was evident that the tissues gave way.

Mud of spleen of a dark purplish-brown color. This dark color was not altered, notwithstanding that it was exposed to the action of the atmosphere for twenty-four hours. When first removed, the mud of the spleen coagulated slightly. The coagulum, however, possessed no consistency, and was readily dissolved. When the mud of the spleen (pulp and extravasated blood) was examined under the microscope, it was found to consist of colored and colorless blood-corpuscles and numerous granules of a black color. These black granules were frequently conglomerated together, forming dark flakes like the coffee-ground sediment of the black vomit of yellow fever. Many of the colored corpuscles appeared to be swollen. The colorless corpuscles appeared to be more numerous than normal.

Alimentary Canal.—Stomach contained no fluid or gas; blood-vessels upon the exterior filled with blood. Mucous membrane of stomach of a dark purplish color. The color of the mucous membrane was not uniform; it was much deeper in some spots than in others, thus presenting a mottled appearance.

The compound muciparous follicles (Brunner's glands) of the stomach and duodenum were prominent and enlarged.

Bloodvessels of the superior and inferior portions of the intestinal canal appeared to be more engorged with blood than those of the middle portions. The mucous membrane of the small intestine was covered by a layer of mucus and fecal matter, colored yellow by the bile.

The solitary glands in the inferior portion of the ileum, and

especially in the region of the ileo-cæcal valve, were enlarged and distinct.

The glands of Peyer were distinct, but not enlarged or inflamed.

The serous membrane of the intestines bore the marks of an old inflammation. The serous membrane was thickened, and organized bands of coagulable lymph in many places bound the large and small intestines together and to the walls of the abdominal cavity. This inflammation had nothing whatever to do with the present attack.

Kidneys normal in size and structure. Blood had settled in the vessels and capillaries of the inferior dependent portions. *Color of superior portions of kidneys normal; color of inferior dependent portions almost as dark as the slate-colored liver.*

The bloodvessels and capillaries of the cellular tissue of the posterior dependent walls of the abdominal cavity were engorged with blood, whilst those of the upper anterior and lateral walls were almost devoid of blood. This was due to the action of gravity upon the enfeebled circulation.

The facts which we have presented show that the capillary circulation had been greatly enfeebled in every organ and tissue previous to death, and the blood necessarily accumulated in the most dependent bloodvessels and capillaries. This view is farther confirmed by the fact that the vena cava contained but little blood.

The bladder contained 5000 grains of light-colored urine.

Reaction acid; sp. gr., 1008.7.

After standing forty-eight hours no deposit was thrown down. This was also true of the former specimen of urine.

	5000 grains of urine contained	1000 parts of urine contained
	Grains.	
Water	4863.140	972.628
Solid matters	136.860	27.372
Urea	38.945	7.789
Uric acid	0.240	0.048
Extractive and coloring matters . .	88.005	17.601
Fixed saline constituents . . .	9.120	1.824

CONCLUSIONS.

(1.) The slate-colored liver, the dark greenish-brown bile, the absence of grape sugar and the presence of animal starch in the liver—the slate-colored, enlarged, engorged, softened spleen—demonstrated that this was a case of malarial fever.

(2.) The rapid and feeble action of the heart; the rapid and feeble pulse; the depressed temperature of the trunk and extremities; the dry, red tongue; the complete exhaustion of the muscular and nervous force; the acid, light-colored urine; the feeble general and capillary circulation, gradually overcome by the action of gravity; the gradual settling of the blood previous to death in the blood-vessels of the most dependent parts of all the organs and tissues; the alterations of the blood-corpuscles of the liver and spleen; the alterations in the color and constitution of the bile; the destruction of the special ferment in the blood which converted the animal starch into grape sugar—demonstrated that the malarial poison had not only interfered with the action of the cerebro-spinal system, but had also affected the sympathetic system, and produced profound alterations in the structure of the nutritive fluids, and correspondingly interfered with the chemical changes, the development of the forces, and the formation of the secretions and excretions.

(3.) The rapid exhaustion of the forces was, without doubt, due, in a great measure, to the severe purgation to which this patient had been subjected previous to his entrance into the hospital, and to his previous intemperate habits, and to the presence of tubercles in the lungs. The administration of large doses of purgative medicines (castor oil and blue pill), without any sulphate of quinia, and without any stimulants, converted an ordinary case of malarial fever into a congestive malarial fever. The term congestive, as applied to this case, means nothing more than a state of exhaustion, inability to resist the action of the malarial poison, inability to react.

(4.) The plan of treatment in this case was correct in principle, but radically deficient in energy. Stimulants were administered, but not in sufficient quantities. Sinapisms were used, but not often enough, nor large enough, nor long enough. Sulphate of quinia was administered, but too infrequently and in too small doses to be efficient, and much valuable time was wasted. This case demanded prompt and vigorous action. Large doses of the sulphate of quinia and the most diffusible and powerful stimulants should have been promptly and frequently administered, and the extremities should have been repeatedly covered with sinapisms.

Case illustrating the Action of Purgatives in Malarial Fever. Principles which should govern the Administration of Purgatives in Malarial Fever.

English seaman; height 5 feet 7½ inches; weight 145 pounds; black hair, brown eyes, dark complexion; age 46; well-built, muscular man. First trip to Savannah. Has been in this port three weeks, and during this time has slept on board ship.

October 13, 1857, 11 o'clock A. M. Says that he was taken sick two days ago, with pain in his head and bones, and loss of appetite. Last night, between 8 and 9 o'clock P. M., had a chill, which lasted for one hour, and was succeeded by fever, which remitted this morning with a profuse perspiration. Tongue pale and clean. Bowels have not been moved for three days.

℞.—Calomel gr. xij; sulphate of quinia gr. vj.—Mix. Administer immediately, and follow with castor oil in four hours. As soon as the medicine has operated once, give gr. v of the sulphate of quinia every three hours, up to gr. xx.

13th, 11 o'clock A. M. The medicine operated freely. Has taken twenty-six grains of the sulphate of quinia. The patient is weak and stupid. Pays no attention to inquiries, even when the voice is greatly elevated. When aroused by violent shaking, answers incoherently, and in a few moments relapses into a stupor. Great tenderness upon pressure of epigastric region; pressure here arouses him, and he cries out. Pulse 120, very feeble; so feeble that it is with difficulty that it can be felt, and with still greater difficulty that its number of beats to the minute can be ascertained; respiration 40, thoracic, labored. Tongue coated with yellow fur, moist, and soft. Skin warm and moist; in a perspiration.

Administered f℥ij of a mixture of equal parts of brandy and infusion of Virginia snakeroot. As soon as the fluids entered the stomach they were ejected again, with great violence, over the table and the neighboring bed. The brandy and infusion of snakeroot had mingled with the contents of the stomach, and were of a green color. The act of vomiting was performed, apparently, without any effort. There was no retching previous to the ejection of the fluids. They came up in a stream.

℞.—Mustards to extremities and interior surface of thighs, and a blister six inches by five over the epigastric region.

℞.—Lime-water f℥ij; milk f℥ij; solution of acetate of morphia

f℥j.—Mix. Administer immediately, and repeat every half hour until his stomach is settled. As soon as the stomach will retain this mixture, administer sulphate of quinia, brandy, and infusion of Virginia snakeroot, freely.

8 o'clock P. M. More sensible than this morning, but weak and restless. Breathing not so accelerated and labored. Pulse 120, still very feeble. Blister is drawing.

℞.—Sulphate of quinia gr. v every three hours, up to gr. xxx.

If his stomach rejects this, give the following injection:—

℞.—Sulphate of quinia gr. x; starch f℥ij; tincture of opium ♏xv.—Mix. Repeat every three hours until forty grains of the sulphate of quinia have been administered. Administer brandy, infusion of Virginia snakeroot, and spirit of mindererus, freely.

14th, 11 o'clock A. M. Says that he is much better. Intellect clear; answers coherently. He is much more quiet. Blister has drawn well; serum golden colored. Pulse 96, much stronger and more regular, but still feeble; respiration, 24. Tongue soft and moist; superior portion coated with white fur. Under the action of sulphate of quinia and stimulants the pulse has diminished in frequency and increased in volume, and the respiration has diminished in frequency, and the spasmodic actions of the respiratory muscles have ceased, and the nervous system has been aroused, and the dull intellect has resumed its normal actions. *If stimulants had been withheld, it is highly probable that this patient would have died* from complete exhaustion of the nervous and vital powers, consequent upon the action of the malarial poison, either directly upon the nervous ganglia of the sympathetic system presiding over the respiration and circulation; or by such changes in the elements of the blood (especially of the blood-corpuscles) as resulted in the perversion of the nutritive elements of the nervous ganglia, or in the generation of compounds in the blood and in the secretions of the liver, spleen, and alimentary canal, which acted as poisons upon the sympathetic and cerebro-spinal nervous systems, or by the simultaneous action of the poison in all these different ways.

℞.—Continue brandy and infusion of Virginia snakeroot. Stop sulphate of quinia. Diet, milk punch and arrowroot.

15th, 11 o'clock A. M. Continues to improve. Has no pain anywhere. Tip of tongue clean and redder than normal; posterior portion coated with patches of black fur. Pulse, 88; respiration, 16. Temperature of trunk normal; reaction of saliva neutral.

℞.—Continue stimulants and nutritious diet.

8 o'clock P. M. Continues to improve. Up to the present time, owing to the action of the medicine, the congestive chill, delirium and weakness, it has been impossible to obtain any urine for analysis. Urine passed this afternoon orange colored. Amount passed during the last twenty-four hours, 5050 grs.; calculated amount for twenty-four hours, 15,510; sp. gr., 1010; reaction acid.

	5050 grains of urine, excreted during 8 hours, contained	15,150 grains of urine, calculated for 24 hours, contained	1000 parts of urine contained
	Grains.	Grains.	
Urea	129.495	338.395	25.642
Uric acid	3.250	9.750	0.643
Fixed saline constituents .	8.500	25.500	1.683

16th, 11 o'clock A. M. Continues to improve. Tongue soft, moist and normal in appearance. Reaction of saliva decidedly acid. His appetite is good. Pulse, 84; respiration, 15. Urine passed during the night, of a deep orange color; sp. gr. 1014. Reaction when first voided acid, after the lapse of fifteen hours slightly alkaline. Simultaneously with the change from acid to alkaline, there was the formation of numerous well formed prismatic crystals of triple phosphate. When the urine was held in the sunlight, these crystals sparkled like particles of silver.

1000 parts of Urine contained—

Urea	24.761
Uric acid	0.029
Fixed saline constituents	1.773

℞.—Continue brandy and infusion of Virginia snakeroot and nutritious diet.

℞.—Quassia and soda.

17th. Greatly improved; dressed and walking about the hospital yard. Pulse, 72. Tongue, skin, respiration and temperature, normal. Complains of nothing but weakness.

The captain of the vessel to which this seaman belonged has just informed me that his crew consisted of eight men and a woman (the cook). Four of the men and the cook slept aboard the ship lying in the Savannah River. Every one was taken sick with malarial fever, and entered the hospital. Of the four seamen who slept ashore, two were taken sick; their attacks, however, were much lighter than those who slept on board the ship.

CONCLUSIONS.

Principles which should govern the Administration of Purgatives in Malarial Fever.

(1.) This case illustrates the necessity of watching the action of purgatives in malarial fever.

I have treated numerous cases of malarial fever, both with and without purgatives, and from a careful comparison of the results of the different modes of treatment, have found that the disease yields much sooner to the action of the sulphate of quinia, after the action of a purgative. The purgative which I have almost invariably employed at the commencement of the disease, is calomel. It was administered in doses from vij to xij grains, conjoined with from v to vij grains of the sulphate of quinia. The liver and portal circulation, and perhaps the spleen to a certain extent, are relieved by the action of the purgative, and the sulphate of quinia is absorbed much more readily and rapidly. The sulphate of quinia appears to affect the head much less after the action of a purgative. I have frequently observed, that in both intermittent and remittent fever, the action of calomel on the alimentary canal, and liver, especially when accompanied by, and followed with large doses of sulphate of quinia, was attended with relaxation of the hard dry skin, increase of the secretions of the dry red mucous membrane of the tongue and mouth, and relief of the cerebral symptoms.

The purgative by no means cures the disease. The purgative simply excites the alimentary canal to eliminate and throw off offending matters, and relieves the congestion of important organs, and thus equalizes the circulation, promotes secretion, and secondarily relieves some of the nervous phenomena. If the patient was left thus without farther treatment, the malarial poison would still continue its work unchecked. The purgative "prepares the system" for the action of sulphate of quinia and stimulants.

In the administration of purgatives in malarial fever, however, the practitioner should always bear in mind the important fact, that there are certain cases, as the present one, and others already recorded, in which purgatives will produce in conjunction with the malarial poison, sudden and dangerous depression of the system. It is important that the practitioner should study carefully the indications for and against the employment of purgatives.

I will state my experience in the following propositions:—

(*a.*) *Whenever there is a full, rapid, bounding pulse, rapid respiration and corresponding chemical change and development of heat; whether the tongue be red or pale, dry or moist; whether the skin be dry or moist; whether the intellect be clear or clouded, a moderate dose of calomel, especially if it be mixed with sulphate of quinia, will prove highly beneficial, and expedite the subsequent action of the sulphate of quinia, and hasten the termination of the disease.*

(*b.*) *Whenever there is a feeble, rapid pulse, and rapid, thoracic respiration, and no corresponding elevation of temperature (in many cases a great depression), with or without a dry, red tongue, with a dry, harsh skin, or with a cold clammy sweat, with or without cerebral disturbance, with or without restlessness, purgatives should be rigidly avoided.*

(*c.*) *Whenever there is a marked want of co-ordination between the actions of the circulatory and respiratory systems, and the chemical changes and consequent development of the physical and nervous forces, purgatives should be avoided.*

(*d.*) If purgatives be administered, without being followed with sulphate of quinia, they act in conjunction with the malarial poison, by diminishing the amount of the blood and depressing the forces.

(*e.*) If purgatives be administered repeatedly with or without sulphate of quinia, they may convert a case of simple intermittent or remittent fever, into one of congestive fever.

(*f.*) The best purgative is calomel.

(*g.*) The proper time for the administration of the purgative, is at the commencement of the disease.

(*h.*) After the free evacuation of the intestinal canal, the purgative should not be repeated.

(*i.*) The action of the purgative in all cases of malarial fever should be carefully watched, and if there is any depression of the forces, stimulants and sulphate of quinia should be immediately and liberally administered, and sinapisms or blisters applied. Carbonate of ammonia is one of the most valuable stimulants in these cases; sulphate of quinia should always be combined with the purgative.

(2.) The tongue did not present the dry, harsh, red appearance, so common in these severe cases.

I have observed that the dry, red tongue, is more common in the first than in the second or succeeding attacks of malarial fever. This patient stated that he had a severe attack of fever, several years ago, on the coast of Africa, at the mouth of the river Sierra Leone. Says that this attack was similar to the present

one. He was out of his head, and no hopes were entertained of his recovery. The fever was of a malignant type. The crew of the ship was composed of eight strong active men, and out of this number, six died. It is highly probable that the disease was malarial fever. It is reasonable to suppose that this severe attack of malignant malarial fever left a permanent impress upon his constitution, and influenced the symptoms of the present attack.

In attempting to account for the different manifestations of disease, we have not, in the present state of science, access to all the data, such as original constitution, previous habits and previous diseases.

It is probable that the course of severe diseases is always modified by the constitution, diet, occupation, and previous habits, whether virtuous or vicious, temperate or intemperate, and by previous diseases, and by the relations of the individual and his ancestors to the climate and soil. We know that in a body of strong healthy men, exposed to precisely the same sources of malarial disease, we may have manifestations of disease, from a slight febrile excitement, scarcely deviating from the condition of health, down to the most malignant type, commonly called congestive fever.

If all have been alike exposed upon the same small ship, to the same poison, whence this difference?

The difficulty and complexity of this problem may be comprehended when we state that, amongst other things, its solution would demand a knowledge of the previous history of the physical, chemical, physiological, and moral influences of soil and climate, and disease upon the ancestors, and even upon the races; would demand a knowledge of all hereditary tendencies, peculiarities of temperament and idiosyncrasy; would demand a knowledge of the relative activity and perfection of the individual organs and apparatus, and of the relations of these to each other; would demand a knowledge of the relations of the vital force to the matter of each organ, and tissue, and apparatus, and to the morbific agent or agents; would demand a knowledge of the action and reaction of the morbific matter upon the different forms of organized structure, and the consequent derangement of the physical, nervous, intellectual, and moral phenomena; would demand a knowledge of the relations of chemical action to the development of the physical and nervous forces, and the action of the intellectual and moral faculties; would demand a knowledge of the correlations of the physical, vital, nervous, intellectual, and moral phenomena; would demand

a knowledge of the relations between physiological phenomena and the phenomena of the exterior universe. Every candid man will admit that the solution of such a problem is impossible at the present time, because the facts are wanting. And they will be long wanting, owing to the extreme complexity of the phenomena.

A thorough knowledge of pathological phenomena, necessarily includes a knowledge of the relations of all the phenomena of the universe. The dignity and glory of a science should certainly depend upon the multitude and complexity of its phenomena. We hope, however, that the day will come when the science of medicine shall be founded upon the immovable basis of inductive philosophy, and the world be compelled to recognize the truth, that the solution of the problems of medicine requires a higher exercise of the reasoning faculties than the solution of the most complicated and difficult problems in physical and chemical science; a higher exercise of the reasoning faculties than the solution of even the grandest problems of astronomy.

Case of Congestive Fever, illustrating the Effects of the Malarial Poison upon the Nervous System, Muscular System and Organs; the Physical and Chemical Changes of the Urine; and also the Formation of Heart-Clots. Treatment of Congestive Fever.

Observation.—German; age, 40; height, 5 feet 9 inches; weight, 150 lbs.; black hair, black eyes; sallow complexion; occupation, bar-keeper.

October 16, 1857, 8 o'clock P. M. Has just entered the hospital. Is unable to give coherent answers, and is either stupid or unable to speak the English language. His companion states that this patient has been in Savannah for two months, and has been sick with chill and fever for two weeks. He is exceedingly weak, and his intellect wanders. Pulse 112, rather feeble.

℞.—Calomel gr. xij; sulphate of quinia gr. vj.—Mix. Administer and follow with castor oil in four hours.

℞.—As soon as the calomel has acted once, commence with sulph. of quinia, gr. v every three hours up to gr. xx.

17th, 11 A. M. When I saw this patient last night, I supposed that this stupidity and difficulty of speech were due, in a great measure, to the fact that he was a foreigner, imperfectly acquainted with our language. A careful examination this morning, however,

shows that the difficulty of speech and torpor of intellect are dependent upon the effects of the malarial poison (either directly or indirectly) upon the brain. When questioned, endeavors to converse; commences sentences, but is unable to finish them. Pulse 124, very feeble; respiration, 28; tongue, dry, hard, and rough, and coated with dry, brownish-yellow fur. The tongue feels very hard and rough. There is not moisture enough in his mouth to produce any sensible effect upon a bit of paper pressed against the tongue. Skin warm and dry. The temperature of the skin corresponds with the feebleness of the pulse, but not to its frequency, and not to the frequency of respiration. Says that he feels well.

℞.—Mustards to extremities. Cut cups to temples and back of neck. ℞.—Administer freely, brandy, infusion of Virginia snakeroot, spirit of mindererus, and sulphate of quinia.

8 o'clock P. M. The cut cups and mustards aroused him for a short time, but he has relapsed into the state of partial stupor, in spite of the action of the sulphate of quinia and stimulants.

℞.—Continue stimulants, infusion of Virginia snakeroot, and sulphate of quinia.

18th, 11 o'clock A. M. No improvement. Tongue very red at edges and tip, which are free from fur. Surface of tongue coated with dry, yellow fur, and presents the same dry, rough feeling and appearance. Teeth coated with sordes. The pulse is so rapid and feeble that it is almost impossible to ascertain accurately its number of beats. It feels like the delicate pulsations of a minute capillary filled with water. The pulsations cease, as soon as the slightest pressure is made. Pulse, 155 to minute. The heart merely thumps (flutters). The two sounds are merged into one, and cannot be distinguished. The sounds of the heart correspond in number to the beating of the pulse, 155 to minute. The correspondence of the two was examined not only by separate calculation, but also by applying the ear over the region of the chest, and the hand over the pulse at the wrist. Respiration 34, spasmodic. Skin covered with cold, clammy sweat. Extremities are at least 20 degrees below the normal standard. Trunk and head feel cold; their temperature several degrees below the normal standard.

The action of the heart is feeble; the capillary circulation is exceedingly feeble and sluggish. The distribution of the nutritive and force elements is correspondingly retarded, and, as a necessary consequence, the chemical changes are diminished and altered both in quantity and kind.

The patient is very restless, tosses about the bed, and is with the greatest difficulty retained in bed. Passes his water and feces in bed. Intellect wandering; talks incoherently. Says that he is perfectly well, and wishes nothing but water. When aroused, his eye looks bright, and there is no expression of pain or uneasiness upon his countenance.

During the last thirty-six hours has taken fifty grains of the sulphate of quinia, together with large quantities of stimulants. Mustards have been frequently applied. The effect of these remedies appears to be only palliative. They have produced no permanent beneficial effect. Whenever the mustards and stimulants were withheld, the forces decreased rapidly, and the patient would relapse almost into a profound stupor. The action of the mustards was very slow on account of the sluggish capillary circulation.

℞.—Continue stimulants. Apply bottles of hot water to the extremities. Administer 10 grains of the sulphate of quinia immediately, and repeat every three hours. ℞.—Blister to back of neck.

9½ o'clock P. M. The mustards and stimulants aroused him, and at 6 o'clock P. M. this evening his pulse was fuller, his tongue was moister, his intellect clearer, and the restlessness had, in a great measure, disappeared. The patient, during the momentary absence of the nurse, got out of bed and attempted to walk across the floor, to the bucket of water at the other end of the ward. He had not proceeded more than five steps, before he fell upon the floor, completely exhausted. Almost immediately his pulse became more frequent and feeble, in fact, almost entirely disappeared, and his extremities became much colder. Mustards were again applied, and stimulants administered. Under the action of these, his circulation, both general and capillary, was increased somewhat in force, and his exhausted forces revived.

Now his pulse is 135, and his respiration 32. The sordes on the teeth, which were this morning perfectly dry, are moister; the tongue is moister; the pulse is fuller (although still exceedingly feeble and flickering), than it was this morning.

There is an unnatural brilliancy about his eye, and excitement about his intellect. He converses freely for the first time; says that he feels perfectly well, and wishes to go immediately home to the hotel and take the place of the bar-keeper, who he says is sick. Complains bitterly of being confined to bed, when nothing is the matter with him, and he feels as strong and as well as he ever did in his life. Has been quarrelling with the nurse, and threatens

vengeance, because he confines him to bed and will not allow him to dress himself and go and drink freely of water. Complains greatly of thirst; keeps his eye fixed on the vessel containing water, notwithstanding that he is liberally supplied. Has vomited several times. The blister is acting, and the serum is of a golden color. Has taken 30 grs. of the sulphate of quinia since 11 o'clock this morning.

Has just passed urine. It is perfectly clear, and amber-colored. *The color of the urine is in striking contrast to that of patients who are able to resist the effects of the malarial poison to the extent of the production of the febrile excitement. When the constitution is able to cope with the malarial poison, we have a rapid pulse, rapid respiration, high temperature, rapid chemical change, and high-colored concentrated urine.* Specific gravity of urine, 1015.3. Reaction strongly acid. The urine changed the litmus blue paper to as bright a red as a strong mineral acid. The rapidity of the change also corresponded to the action of a powerful acid. After standing 70 hours the reaction was still decidedly acid, and there was no deposit of any kind. When the urine was evaporated, the residue was a dark reddish-brown viscous mass, resembling tar. After prolonged, tedious, and careful evaporation, it was found to be impossible to reduce it to a solid state. When the urine, concentrated to the consistence of a syrup, was treated with nitric acid, there was a slight effervescence, and a few crystals appeared. These crystals were transparent, and resembled rather crystals of saltpetre than the silvery crystals of nitrate of urea. After standing for a short time these crystals disappeared, and did not again appear even when the fluid was concentrated by evaporation. If these crystals were nitrate of urea, the whole amount existing in 1000 grs. of urine must have been less than 2 grs. In a fluidounce of urine not more than a trace of uric acid could be detected after careful examination. Under the microscope a few small crystals could be detected which were invisible to the naked eye.

1000 parts of Urine contained—

Solid matters	34.482
Water	965.518
Urea	a trace
Uric acid	a trace
Extractive, coloring, and organic matters	24.805
Fixed saline constituents, principally phosphates	9.655

The fixed saline constituents were principally the phosphates.

A short time after this observation the excitement and restlessness of this patient disappeared, and he went into a profound sleep and *died at* 1 *o'clock A. M.*

AUTOPSY TWELVE HOURS AFTER DEATH.

Exterior.—Limbs and trunks round and full, and apparently in full flesh. The skin over the whole surface except the face presented a fair white color. There was no settling of the blood in the capillaries of the most dependent portions of the skin producing the mottled appearance previously noticed. This may be due to the fact that the patient was under the action of stimulants at the time of death.

Head.—Dura mater, normal. *Arachnoid* membrane opalescent (pearl colored) in many spots. Serum was effused between the arachnoid membrane and pia mater. Bloodvessels of pia mater, filled with blood. Substance of brain was firm, and was altered neither in consistency nor in appearance. Bloodvessels of the substance of the brain not more distinct than normal. Ventricles of the brain were almost entirely filled with light-yellow serum. Light-yellow serum was effused around the medulla oblongata, and superior portion of spinal cord. The effused serum appeared to fill completely the spaces between the spinal cord and its membranes and the surrounding vertebral cavity. When the medulla oblongata and superior portion of the spinal cord were removed, the serum flowed in (the shoulders being slightly depressed) and filled the vertebral canal.

Chest.—Lungs normal. Bloodvessels of the dependent portions engorged with blood.

Heart normal in size and structure. The ventricles and auricles contained clots. Portions of these clots were free from colored corpuscles and presented the yellow color of whipped fibrin. Surrounding, and attached to these, were ordinary coagula of blood. The vena cava, and all the large venous trunks in the abdominal cavity, were filled with dark, almost black coagulated blood.

Abdominal Cavity.—Liver, somewhat enlarged; and presented a singular mottled appearance. At a distance it presented a light bronzed color. Upon nearer inspection, the lobules were found to be distinct, elevated, and of a light-bronze color, whilst the spaces between the lobules inclined to a slate color. There were several spots varying from two inches to half an inch in diameter of a uni-

form slate color. The structure of the liver was unusually firm; it required considerable force to tear it asunder; it cut toughly under the knife, and the lobules started out from the cut surface as if they had been bound down. The fibrous capsule surrounding the exterior of the liver and forming a sheath for the large vessels lying in the portal canals was thickened, and the individual lobules of the liver were surrounded with fibrous tissue. These facts, which were demonstrated not only by the touch and naked eye, but also by the microscope, show that this liver was in a cirrhosed condition. Cirrhosis of the liver in this case was not caused by the action of the malarial poison, but in all probability, by the habitual use of ardent spirits.

This patient was a barkeeper. Men in this occupation are, as a general rule, addicted to the free use of ardent spirits. The liquors drank in this country at the hotels and bar-rooms contain much alcohol, which acts upon the secreting structures of the liver and upon the bloodvessels, and excites adhesive inflammation in the areolar tissue of the small twigs of the portal vein, and in the areolar tissue of the portal canals, by which serous fluid and coagulable lymph are thrown out. Under the microscope, the substance of the liver contained many dark looking masses, resembling the altered blood-corpuscles of the spleen, and the black granules and flakes of black vomit. These dark masses were not sufficiently numerous to have any marked effect upon the organ. When the fibrous capsule was torn off it presented a light slate color, and yet when magnified and carefully examined, but few of these dark masses were seen in the meshes. The structures of the liver, and the liver-cells, contained numerous oil-globules. These oil-globules existed in sufficient numbers to induce the belief that the liver was in a state, not only of cirrhosis, but also of fatty degeneration. The bloodvessels of the liver were filled with dark blood, which did not change to the arterial hue upon exposure to the atmosphere.

The mottled appearance of the liver, and the want of that decided slate and bronze color characteristic of malarial fever, were due not to any peculiarity of the effects of the malarial poison, but rather to the pathological conditions of cirrhosis and fatty degeneration. Allowing due weight to these pathological changes, it is evident that the change in the color of the liver was similar in all respects to the slate, or bronze color of livers, which were normal before the onset of the malarial fever. The change in the color of the liver

during malarial fever is due to changes in the amount, and physical and chemical constitution of the blood in the capillaries of the liver, and to the physical and chemical changes in the bile and the contents of the secretory apparatus, and not to the deposition of black granules in the structures of the liver. I have seen the slate and bronze color as well marked in the liver when these dark masses were absent, as in the liver where they were most abundant. The peculiar color of the liver is due, in a great measure, to changes in the coloring matter (hæmatin) of the blood. The blood will not change to the arterial hue when exposed to the atmosphere. This altered coloring matter resulting from the destroyed disintegrated blood-corpuscles, or from the blood-corpuscles acted on by the malarial poison, without actual disintegration, escapes and permeates the surrounding tissues and imparts the peculiar color to the liver. The color is also due to the altered color of the bile.

In all the cases of malarial fever which I have thus far examined, I have found the bile to be of high specific gravity, thick, concentrated, and of a greenish-black color, when seen in mass, and of a gamboge yellow when spread in thin layers. The altered bile also infiltrates the surrounding tissues and gives this peculiar color to the liver. This peculiar color can be to a certain extent abstracted from the liver by boiling with water. I have always found the filtered decoction of malarial fever livers to be of a brownish-yellow color, whilst the decoction of yellow fever livers is of a bright golden color, whilst that of normal livers is of a light-yellow. After the altered coloring matters of the blood and bile have infiltrated the structures of the liver, they will sometimes remain for a considerable length of time without being absorbed, and communicate the peculiar bronzed color to the liver long after the restoration of its normal functions, and the disappearance of the malarial fever. I have observed, however, that the intensity of the color of the liver bears a marked relation to the time of convalescence; as convalescence advanced the color diminished in depth.

The liver contained animal starch. Several of the hepatic ducts were isolated and treated with tincture of iodine and carefully observed under the microscope. Their color, with the exception of a few small spots, was simply changed to that of the tincture of iodine. In these spots, the color was changed to a bright blue. In other cases of malarial fever, I have seen long portions of the hepatic ducts changed to a bright blue color under the action of the

tincture of iodine. These facts would show that they do sometimes contain animal starch.

The *gall-bladder* was filled with concentrated bile of the consistency of molasses, and of the color (when seen in mass) of a saturated solution of iodine. When spread in thin layers the bile presented a gamboge color.

Spleen enlarged. It was at least three times the normal size. The structures of the spleen were so much disorganized, that in attempting to remove it from the abdominal cavity, the capsule and trabeculæ gave way under a slight pressure, and the fingers plunged into its soft substance. Dark brownish purple, almost black mud flowed from the rupture. After thirty-six hours' exposure to the atmosphere, the color of the mud of the spleen remained unchanged.

Under the microscope, the mud of the spleen contained a great number of dark, reddish-brown and reddish-black granules, and conglomerations of granules. These granules and black masses, composed of conglomerated granules, resembled the bodies found in the liver, and also the black sediment of the black vomit of yellow fever.

Similar granules and masses have been observed in normal spleens. They appear, however, to be most abundant in the malarial fever spleens of long standing. In cases which have terminated fatally after only a short illness of only two or three days, I have observed that these granules were not so numerous as in cases of longer duration, and in some very recent cases they were not more numerous than in the spleen of health. These masses appear to be derived from the disintegrating blood-corpuscles.

Alimentary and Intestinal Canal. Stomach.—Bloodvessels upon its exterior filled with blood. Mucous membrane bore no marks of inflammation, and was not more congested with blood than usual. The exterior and mucous membrane of the jejunum presented the usual appearance. There was no unusual appearance either of congestion, irritation, or inflammation. The mucous membrane of the ileum, especially at the lower portion, was more congested, and of a darker color than usual.

The intestinal canal throughout its entire length was empty. The mucous membrane presented a yellowish appearance, probably due to the presence of bile.

The solitary glands of the ileum especially in the neighborhood of the ileo-cæcal valve, were numerous, enlarged, elevated, distinct,

and of a brown color. When the intestines were held up to the light, the bloodvessels filled with blood could be distinctly seen sending off branches to each gland. The glands of Peyer were large, distinct, and elevated. Several of these glands in the lower portion of the ileum, were three inches in length. These glands, however, were not inflamed, as in typhoid fever, but presented the usual pale appearance.

Kidneys.—Each kidney had upon its inferior surface a spot about one inch in diameter, of a slate color, resembling, in all respects, the color of the exterior of the malarial fever liver and spleen. When these portions of the kidney were cut, they presented a bronzed color for the depth of one-eighth of an inch. Microscopical examination showed the absence from these portions of the liver of those granules, and brownish-red and reddish-black masses, so abundant in the spleen and liver. Microscopical examination showed that the excretory structures of the kidney were not altered in these discolored portions.

These facts sustain the assertion that I have previously made that the color of the liver in malarial fever does depend upon the diffusion through its substance of dark granules and granular masses. The bladder was empty. The scrotum was reddened, and appeared to be blistered and excoriated. This was due to the action of the intensely acid urine.

CONCLUSIONS.

1. This case corresponds to the congestive fever of American writers. The prominent symptoms of this case were rapid, full pulse; rapid, thoracic respiration; relaxed skin, with cold clammy sweat; sluggish capillary circulation; deficient and perverted chemical action; reduced temperature; deranged physical, muscular, and nervous forces; and aberrated intellectual action.

2. The rapid, feeble, action of the heart; the rapid, feeble pulse; the almost entire arrest of the circulation and chemical changes in the capillaries, were attended by a reduction of temperature, and loss of muscular and nervous force, and aberration of the actions of the sympathetic and cerebro-spinal nervous systems. These disturbances of the chemical changes, and physical, muscular, and nervous forces were reflected in the urine. *The appearance and chemical constitution of the urine were strikingly different from the urine of those cases of intermittent and remittent fevers where the action of the*

poison is attended by an excitement of the general and capillary circulation and of the respiration, and corresponding rapid chemical changes, and high temperature. In those cases of malarial fever where there is a rapid, full pulse; moderately accelerated respiration; rapid introduction and distribution of oxygen and corresponding high temperature, the urine is invariably high-colored, concentrated, and rich in solid matters.

If we examine the analyses of the urine of those cases of intermittent and remittent fever, which have been previously recorded; and, at the same time, bear in mind the fact that the urine was excreted during the summer season, and during starvation; it is evident that during the febrile excitement the urea is greatly increased.

When the febrile excitement (rapid distribution of oxygen, and rapid chemical change, and high temperature) subsides, the urea and other solid constituents of the urine decrease.

After the establishment of convalescence, when the patient is able to take food freely, the solid constituents of the urine again rise, notwithstanding that the temperature is the same, or a few degrees above that of the intermission. The urea during convalescence is probably derived partly from the food, and partly from the metamorphoses of the tissues. *In this case, on the other hand, the arrest of the circulation and chemical changes of the capillaries, and the reduction of temperature, was attended by a complete alteration of the physical and chemical constitution of the products resulting from the metamorphoses of the blood, organs, and tissues. The urea and uric acid were absent, the acid of the urine was greatly increased, and the physical properties of the urine altered.*

Whether the disappearance of the urea and uric acid resulted from the arrest of the metamorphoses of the muscular tissue, or of the blood-corpuscles and nitrogenized elements of the blood; or from the disturbance of the normal chemical changes, by the introduction of the malarial poison, amongst the substances undergoing chemical change; or from the primary action of the malarial poison upon the sympathetic and cerebro-spinal nervous systems, and the perversion of the chemical changes of the organized elements, by the consequent aberrated nervous action; cannot be definitely answered in the present state of chemical, physical, physiological and pathological science, because the fundamental facts are wanting.

Whilst it is known that urea and uric acid are products of the chemical changes of the nitrogenized elements, still it has not as

yet been definitely settled whether urea and uric acid[1] result from the metamorphoses of the blood-corpuscles, or of some one special nitrogenized constituent of the blood, or of the muscular tissue: or from all these sources.

The chemical, physical, physiological and pathological properties and relations of the malarial poison are unknown. What relations, chemical, physical, physiological and pathological, do the metamorphoses of the organized bodies which result in the formation of urea and uric acid, and of the extractive and coloring matters, bear to the metamorphoses induced by the malarial poison? It is impossible to give any answer to this important question, which lies at the foundation of the solution of the problem.

Neither would the answer of this important fundamental question clear up the difficulty, for we have here complicated pheno-

[1] The following observations are interesting in their bearings upon the origin of uric acid. I kept a large Indigo snake (coluber couperi) in a cold, dry room, during the winter season, without food and drink. This serpent remained in a partially torpid state for three months. He was never entirely without the power of motion, and would, when aroused, show considerable power. At the end of this time the serpent died. When the heart was exposed after death, its surface was covered with a chalky granular substance, which was demonstrated both by microscopical and chemical analysis, to be the urate of ammonia. The external surface of the aorta and its largest branches were in like manner covered with the urate of ammonia. When the substance of the heart was cut, numerous particles of the urate of ammonia were found along the course of the bloodvessels and amongst the muscular fibres. Numerous particles of the urate of ammonia were also discovered amongst the fibres of the muscular coat of the aorta and its largest branches. When a portion of the muscle of the heart, or of the muscular coat of the aorta was treated with acetic or hydrochloric acid under the microscope, thousands of small lozenge-shaped crystals of uric acid were discovered lying around the muscular fibrillæ. The urate of ammonia was deposited in no other organ or tissue except the heart and the aorta, and its largest branches. The following appears to be the explanation of this singular phenomenon: The heart was the only portion of the muscular system in continual action during the season of hybernation. Muscular force is developed by chemical change. The heart, therefore, was the only portion of the muscular system undergoing chemical change. The blood was concentrated, deficient in water. There was not sufficient water to dissolve the urate of ammonia, resulting from the chemical changes of the blood and muscles of the heart, by which the muscular force was developed. The urate of ammonia consequently remained just where it was formed. *This observation not only points to the origin of uric acid and ammonia in the animal economy, but also demonstrates that the muscular force is developed during the chemical changes of the elements, of the blood and muscles. If these conclusions be legitimate, true and universal, it follows as a necessary consequence, that any alteration in amount or kind of the chemical changes of the blood and muscular tissue, must be attended by corresponding alterations in the amount and kind of the products resulting from those chemical changes.*

mena and numerous complicated actions and reactions. So complicated and involved are the phenomena that the solution of one necessarily demands the solution of all.

Such questions as these demand an answer:—

What is the chemical, physical, physiological and pathological relations of the malarial poison to the sympathetic and cerebro-spinal nervous systems?

What is the effect of derangement of the *sympathetic nervous system* upon secretion and excretion, in fact upon all chemical changes of the elements of the human organism?

Will the derangement of the secretions and excretions differ with different poisons, when the actions of those poisons are limited simply to the *sympathetic nervous system?*

What is the effect of derangement of the *sympathetic nervous system* upon the *cerebro-spinal nervous system?*

Can the *sympathetic nervous system* induce alterations in the actions of the organs and tissues, in the secretions and excretions, independent entirely of any direct action, but by communicating or reflecting its aberrated action to the cerebro-spinal nervous system?

What is the effect of derangement of the *cerebro-spinal nervous* system, upon secretion and excretion, in fact upon all the chemical changes of the elements of the human organism?

Will the derangements of the secretions and excretions differ with different poisons, when the actions of those poisons are limited simply to the *cerebro-spinal nervous system*?

What is the effect of derangement of the *cerebro-spinal nervous system*, upon the *sympathetic nervous system*?

Can the cerebro-spinal nervous system induce alterations in the actions of the organs and tissues, in the secretions and excretions, independent entirely of any direct action, but by communicating or reflecting its aberrated action to the *cerebro-spinal nervous system.*

Would the phenomena of nervous and muscular action and of secretion and excretion, vary, if the action of the poison or poisons were primarily upon the blood, rendering it unsuited to the healthy action of the cerebro-spinal and sympathetic nervous systems and of the muscular system, rendering it unsuitable for the formation of the secretions and excretions?

Notwithstanding the absence of the facts necessary for the absolute solution of these complicated phenomena, and problems, still the present observations, that arrest of capillary circulation and chemical change, due to the action of the malarial poison, was

attended by a reduction of the temperature, aberrated muscular and nervous action, and a marked alteration of the properties of the urine, are of great interest in their bearing upon the treatment of congestive fever.

3. In the treatment of that form of malarial fever called congestive fever, those remedies should be employed, which excite the general and capillary circulation, promote the introduction and distribution of oxygen, increase the chemical changes, and excite the development of the muscular and nervous forces. Sulphate of quinia and diffusible stimulants, brandy, and carbonate of ammonia should be freely and promptly administered, and sinapisms freely applied. Bottles of hot water, or, better still, the hot water bath, should be used to impart heat and stimulate the capillary circulation, and relieve the engorgement of the large organs. Brandy and red pepper may be applied to the surface with advantage. The sulphate of quinia may be administered in doses of 15 to 30 grains every one, two, or three hours, according to the urgency of the symptoms, up to from 30 to 100 grains during the twenty-four hours. The best method of administering the sulphate of quinia is dissolved in a weak solution of citric acid or in lemon juice. It is perfectly soluble in this, and is much more readily absorbed when in this soluble form. If the stomach rejects the sulphate of quinia, it should be administered in solution with starch, by the rectum. These stimulants will in many cases be the means of prolonging life until the sulphate of quinia can be absorbed and act. Whilst therefore the stimulants do not cure the disease, they often preserve life by supporting the patient until the sulphate of quinia can act.

The carbonate of ammonia is peculiarly valuable in that form of malarial fever where there is a rapid feeble pulse and corresponding rapid feeble action of the heart. The observations which I have recorded in the previous numbers of this journal prove that heart-clots are almost always formed previously to death from malarial fever. It is probable that cases often occur where the sudden and distressing symptoms are due in a great measure to the formation of these heart-clots during life.[1] The feeble action of the heart,

[1] The following observations of Dr. Chisholm are exceedingly interesting in their bearings upon the preceding investigations upon the formation of fibrinous concretions in the heart and bloodvessels, during malarial fever:—

"A SHORT ACCOUNT OF THE EPIDEMIC POLYPUS AT GRENADA, IN 1790.

"The situation in which this singular disease appeared is rather peculiarly circumstanced. The foreground is the sea, perfectly open, with an extensive and

and the sluggish circulation of the blood, are very favorable to the formation of these heart-clots. The free administration of the

burning beach of sand; on the left is a hill of considerable and steep ascent, the base sides of which, in conjunction with the reflecting surface of the sea, produce in dry seasons an immense degree of heat; on the right the view is limited by a mountain of great height and magnitude; the background is a marsh extending from the sea to the mountains, and formed chiefly by water rushing from a narrow stony ravine, and dammed up by a beach rendered impenetrable by the surge: from this marsh vapors of a very deleterious nature continually exhale, and this was particularly observable in the month of October of this year, on account of the trees and brushwood, which hitherto had covered it, being cut away in order to drain the marsh. Immediately behind the marsh the ravine begins, and runs back between the hill and mountain, in the form of a funnel, gradually rising for upwards of a mile. Through this ravine there is a continual current of wind of an uncommon degree of coolness. The negro houses of the plantation are built on the left, chiefly on its slope, and towards the edge of the marsh. The negroes were consequently at once exposed to excessive heat, a cold chilling current of air, and the miasma of the marsh. Their diet was chiefly composed of vegetable food. They had been employed immediately before the appearance of the disease in question, in clearing the surface of the marsh, and in holing land for the reception of cane plants. Like all other negroes placed in similar situations (marshy), they were much given to the destructive habit of eating a species of pipe-clay, very abundant in Grenada.

"The disease made its appearance on the plantation Grand-mal, about the end of September or beginning of October; was most prevalent towards the close of the latter month, and disappeared totally in November. The whole number of sick might have been forty, of whom seven died. Its commencement was marked by no distinguishing symptom; but soon after, the patient complained of pain at the pit of the stomach and in the head, and difficult respiration. These pains were attended with a dry skin, small quick pulse, and slight frequent dry cough. No febrile heat accompanied these symptoms; on the contrary, the surface was at this period remarkably cool; but a heaviness and dulness of eye, a melancholy or depression of spirits, and features strongly expressive of anxiety were constant attendants. The state of the patient was thus characterized for three days. At the expiration of that period, the pulse became extremely quick, 120 to 140, and intermitted, attended with a penetrating pungent heat, which produced a pricking sensation on the hand of the person feeling the pulse. But this state of the pulse and heat, as well as the pains, anxiety, and other distressing symptoms, now also intermitted, or rather the disease assumed something like an intermittent form, the intermission of it may be so called, continuing eight or nine hours. During the paroxysm, the struggle for breath, the aggravation of all the other symptoms, and the very quick, interrupted, and evidently visible, as well as audible palpitation of the heart, produced a scene of uncommon horror. The paroxysm was succeeded by a cold clammy sweat, and a state of approaching syncope. The second paroxysm generally put a period to the existence of the patient. The disease was also distinguished during this latter stage, and even for some time previous to its commencement, by a constant or almost constant disagreeable clammy sweat overspreading the face, the upper extremities and the body as low down as the scrobiculus cordis, all below remaining arid and parched in a most remarkable degree.

carbonate of ammonia, in congestive fever, will fulfil two indications: 1st, stimulation; 2d, prevention of the formation of fibrinous clots in the heart and large bloodvessels.

The disease seemed sometimes inclined to terminate by metastasis; one instance of this was remarkable, wherein a spontaneous absorption of the lymph deposited in the heart, and a deposition of it in the left arm and left thigh took place. The patient, in this case, after laboring under all the symptoms peculiar to the disease before the intermittent period, found himself all at once, and without an evident cause, relieved of them; but he perceived at the same instant an excruciating pain a little above the elbow, and nearly about the middle of the thigh. He continued ever after absolutely free of all the symptoms of the polypus; but they were succeeded by a large abscess in the parts in which he felt the pain. That in the arm disappeared gradually, but the other became so large as to occupy the whole of the under part of the thigh. The cure was effected by passing a seton through the whole length of the tumor; by the use of two dozen of Madeira wine, a large quantity of bark, and a calomel pill, with opium three times a day. The audibleness of palpitation may be considered as exaggeration; but in one instance particularly, the gentleman (Mr. M'Sween) to whom the negroes belonged, heard distinctly the palpitation, although in an adjoining room.

"What mode of practice did so extraordinary a train of symptoms indicate? I could fix on none till dissection instructed me. Having no suspicion of the heart being the seat of this uncommon malady, I did not examine that organ in the two first bodies I opened; but finding all the other viscera, and the brain in a state of health, I found myself still unable to account for the extraordinary symptoms the patients had been afflicted with. At length, on opening the third body, I examined the heart, and discovered what I conceived might be considered the cause and seat of the disease. In the right ventricle of the heart I found a polypus which extended considerably into the pulmonary artery. On extracting it, it measured exactly two feet and two inches in length; and the body of it contained, in the ventricle, two inches in breadth. In the fourth body there was a very large polypus in the right and left ventricle, besides one in the right auricle. The hearts of the fifth, sixth, and seventh, were circumstanced precisely similar; and in the five, except one where the lungs were morbidly affected, no other morbid appearance of any description could be perceived. Did these extraordinary circumstances justify the appellation—epidemic polypus?

"After a variety of ineffectual attempts to cure this disease, I determined on the following, and found it successful: From the consideration of the circumstances contributing to the production of the disease, so far as they were discovered; of the features of the disease itself; and of the morbid changes observed in the dead bodies; it may be fair to conclude, that a laxity of fibre, a want of due cohesion in the mass of blood, and a consequent deposition and accumulation of coagulable lymph in the cavities of the heart, where the various valves and columnæ favor such accumulation, produced polypi, an interruption, and at length a total stop to the circulation. Having this view of the disease, it was manifest that such means as might prevent deposition and accumulation of coagulable lymph, or destroy it, should it have happened, in the first instance; and afterwards restore tone to the fibre, would cure the disease. The action of mercury on the absorbent system I had for some time been acquainted with, and its probable efficacy in that way here, readily occurred to me. My mode of treatment, therefore, was this:

4. The failure of this mode of treatment to prevent a fatal termination in this case was due to several causes. The disease had been allowed to progress without any opposition for at least ten days before this plan of treatment was instituted. During this time such profound alterations of the blood, spleen, and liver had taken place, and the chemical changes so perverted and the correlation of the physical, vital, nervous, and muscular forces, so disturbed, that no plan of treatment, however vigorous, however appropriate, could arrest the progress of the disease.

The symptoms were without doubt aggravated by the cirrhosed condition of the liver. The alterations of the color of the blood and of the secretions of the liver in malarial fever, point to profound alterations. The cirrhosed condition of the liver would necessarily increase these morbid effects. The cirrhosed condition of the liver also points to the former intemperate habits of the patient, and the effects of these upon the constitution, no doubt influenced materially the course of the disease. *As far as my observations upon malarial fever extend, I can assert that this disease most frequently proves fatal in those who have been addicted to the intemperate use of ardent spirits, and especially in those in whom a cirrhosed condition of the liver has been induced by the free use of ardent spirits.* This statement is worthy of the attentive examination and consideration of the profession.

It is probable that the fibrinous clots found in the heart were formed some time before death, and if they did not determine, they at least hastened the fatal termination.

5. In this case the marked reduction of the temperature of the

The moment I could distinguish the disease, I bled, in order to render circulation through the lungs and heart less difficult and obstructed. This evacuation was never repeated without great caution, and the most evident necessity. After this I gave calomel in doses of five grains, guarded with opium, every fourth hour, and continued it until salivation was excited. Under this treatment I lost not a single patient, the fatal terminations having taken place before I could carry it fully into execution.

"A pneumatic physician would probably refer all to the hydrocarbonate of the marshy exhalations, and attribute the cure to the oxygen disengaged from the mercury, assisted by the stimulus of the metal. Whether such might be correct reasoning or not, I am certainly induced to consider the history taken altogether as an illustration of the theory of the curative action of mercury in the system; and as such I have judged it worthy of the reader's notice." (An Essay on the Malignant Pestilential Fever introduced into the West Indian Islands from Boullam, on the Coast of Guinea, as it appeared in 1793, 1794, 1795, and 1796. By C. Chisholm, M. D. London, 1801, vol ii. Appendix No. 6, pp. 454—460.)

trunk and extremities was unattended by the shivering and sensations of cold characteristic of the chill of intermittent and remittent fever.

The observations which I have recorded have established that in the chill of intermittent and remittent fever the temperature of the trunk is actually elevated several degrees above the normal standard, whilst the temperature of the extremities is depressed many degrees below the normal standard. In this state of things we find a feeble pulse, feeble circulation of the blood in the capillaries of the extremities, diminished chemical action in the capillaries of the extremities, accumulation of blood in the large organs of the trunk, and increased chemical change in the blood and large organs of the trunk. This state of things is attended by shivering of the muscles and a sensation of cold, just as a similar reduction of the temperature of the extremities in cold weather would be attended by shivering of the muscles and a sensation of cold.

On the other hand, in that form of malarial fever called *congestive fever*, where the temperature of both the trunk and extremities is depressed, the patient often complains of no sensation of cold, and, in some instances, even says that he feels perfectly well, and there is no shivering of the muscles. Here we find a feeble general and capillary circulation and an arrest and perversion of chemical action, both in the trunk and in the extremities.

Whence this difference?

Without attempting to decide dogmatically upon the solution of these complicated phenomena, we would simply state that in congestive fever the chemical changes in all parts of the body are so diminished and perverted, and the correlation of the forces so disturbed, that the muscular system ceases to indicate by shivering and aberrated action, and the nervous system ceases to indicate by the sensation of cold, the depression of temperature consequent upon the arrest of capillary circulation and chemical change. As muscular and nervous force, and even sensation, depend upon chemical change, it is but reasonable to suppose that a marked perversion and diminution of chemical change should be attended by an arrest of muscular and nervous action, and even of sensation. In congestive fever, whether from peculiarities of constitution or from the overwhelming amount of the poison introduced, those chemical changes are not excited, which result in the breaking up and removal of the malarial poison.

The febrile excitement following the chill of intermittent and

remittent fever, appears to be due to the equalization of the general and capillary circulations; and to the distribution through the blood-vessels and capillaries of all parts of the body, of the substances undergoing active chemical changes, developing high temperature, which during the chill were confined to the trunk.

The equalization of the capillary and general circulations is, without doubt, dependent in great measure, primarily, upon the action of the sympathetic nervous system; and, perhaps, may be secondarily and remotely affected by the action of the cerebro-spinal nervous system. We say *dependent in great measure*, but not absolutely, and entirely, upon the sympathetic nervous system; because the malarial poison may act, in addition to the modes already pointed out, directly upon the fibres of the heart, and thus influence circulation, and through it respiration, and chemical change, and temperature, and muscular and nervous force, and the manifestation of intellectual phenomena, independently altogether, of any direct and primary action upon either the sympathetic or cerebro-spinal nervous systems.

It is highly probable that, during the febrile excitement, the malarial poison is drawn into the round of chemical changes, and so altered, that its action is for a time suspended. Hence the intermission, or remission.

The fever, then, is a favorable symptom, and the want of fever, a most unfavorable symptom; and if these views be true, the paroxysms of malarial fever are due to the alterations and partial destruction of the poison during the active chemical changes of the febrile excitement.

The manifest duty of the physician in congestive fever (if these views, which have been suggested by the results of actual observation and experiment, be correct), is to administer those remedies which will excite the general and capillary circulations—excite chemical change—excite fever, and arouse into vigorous action the sympathetic nervous system, and destroy, or counteract, or paralyze the action, or eliminate the malarial poison.

Case illustrating the Power and Rapidity of the Action of the Malarial Poison in Congestive Fever and Changes of Blood in the Liver and Spleen.

American seaman; age 25; height 5 feet 9 inches; weight 150 pounds; dark complexion, dark-brown hair, brown eyes.

October 19, 1857, 8 o'clock P. M. This patient entered the hospital three hours ago, at 5 o'clock P. M., in an almost insensible condition. Now he is aroused with great difficulty and answers incoherently. Extremities cold. Pulse 80, feeble. Head and trunk cooler than normal. Tongue by the gas light appears clean, soft, and normal in color.

℞.—Cut cups to each temple and back of neck.

℞.—Mustards to extremities and over epigastric region.

℞.—Sulphate of quinia gr. v; camphor gr. ij. Mix, and administer every three hours until fifty grains of the sulphate of quinia have been taken.

℞.—Spirit of mindererus, brandy, and infusion of snakeroot f℥ss of each, alternately every half hour.

20th, 9 o'clock A. M. Lies in a profound coma. This came on a short time after the first observation yesterday evening. The cut cups aroused him partially for a few moments, but he soon relapsed. Mustards have been applied to the extremities and epigastric region three times during the night; they failed to rouse the brain; they excited the capillary circulation and induced an elevation of temperature, but did not restore reason. The stimulants also failed to arouse the intellect. Whenever the mustards were removed and the stimulants withheld his surface became cool and the pulse diminished in volume. It is evident, then, that the mustards and stimulants excite the general and capillary circulation, and induce an elevation of temperature, but they do not arrest the disease. During the night has passed his urine and feces in bed. Pulse 140, full. The sounds of the heart are not distinct; they cannot be distinguished, but sound to the ear like one sound. The beating of the heart-sounds stronger even than in health. The sounds of the heart correspond in frequency to the beat of the pulse, 140 to the minute. Respirations 40, spasmodic. Temperature of atmosphere, 70° F.; temp. of hand, 104°; temp. in axilla, 104.5°. Great tenderness of epigastrium. Whilst neither shaking nor loud talking will arouse him, pressure upon the epigastrium causes him to emit a short cry. The epigastrium and region of the liver feel to the hand warmer than the head or any other part of the body. Complexion very sallow. I administered gr. xxx of sulphate of quinia in f℥ij of brandy. It was with great difficulty that the spoon was forced between his clenched teeth. The dose had not been swallowed more than a few moments before it was ejected violently, apparently without any effort or consciousness on the part of the

patient. This dose was again repeated, and his trunk and extremities covered with mustards, and bottles of hot water applied to the feet, without producing the slightest good effects. *This patient died one hour and a half after these observations.*

AUTOPSY TWENTY-FOUR HOURS AFTER DEATH.

Body not emaciated; apparently in full flesh. Has the marks of a large ulcer over the superior portion of the sternum. Skin of the dependent parts of the body of a purplish hue. The discoloration of the skin commences about the middle of the body and gradually increases downwards, until the most dependent portions are of a deep purple color.

Head.—When the skullcap was removed, much blood flowed out. Arachnoid membrane opalescent, in a few spots. Bloodvessels of pia mater filled with blood. Bloody serum was effused between the arachnoid and pia mater. Bloodvessels at the base of the brain and surrounding the medulla oblongata and superior portion of the spinal cord, congested with blood. Blood was effused upon the base of the brain. This blood was fluid, and contained no coagula. The substance of the brain was normal in consistence and appearance.

Chest.—Heart, normal; right auricle and ventricle contained a small clot, left heart empty. *Lungs*, normal; dependent portions congested with blood. Bloodvessels of superior portions almost entirely free of blood.

Abdomen—Liver.—A large portion of the surface of the liver presented the healthy Spanish brown color, and, when cut, the substance presented the usual healthy color. Other portions, however, presented a mottled appearance of Spanish brown and dark purple, and the bloodvessels of these parts appeared to be engorged with blood. The right lobe of the liver had upon its under surface a spot about two inches in diameter, of a dark slate (malarial) color. When an incision was made through this portion of the liver, it presented for the depth of about one-fourth of an inch, the true bronze color. Numerous incisions were made into the liver in all directions, so as to expose its substance fully to view; portions were found approaching in color the bronze hue of the malarial fever liver; the great mass of the liver, however, resembled more nearly that of a healthy liver, engorged with blood. Portions from different parts of the liver were examined under the microscope.

The liver cells from the slate colored and bronzed portions did not differ in appearance, under the microscope, from those of the normal colored, or from those of the mottled portions. The colored corpuscles appeared to be more altered in form in the bronzed portions than in the normal colored portions. The alterations, however, even in the bronze portions, were small and by no means universal, but confined comparatively to a few, and, after all, the difference may have been imaginary. The determination of comparative alterations of this kind is not so easy as at first sight appears. Did not discover any of those dark granules in the bronze portion, which have been said to impart the peculiar color to the liver. From the cut surface of the liver, much black blood issued, which assumed, upon exposure to the atmosphere, the arterial hue. The liver-cells did not appear to be altered in any manner.

Gall-bladder, filled with bile. *Specific gravity of bile*, 1042.5. Viewed in mass, the bile was of a brownish-black color, with greenish reflections, and resembled, upon a general view, a saturated tincture of iodine. It resembled, and poured like molasses, being thick and ropy. Upon close inspection, the bile was found to contain numerous flakes of a green color, which, under the microscope, were found to consist of the conglomerated cells of the mucous membrane of the gall-bladder. When spread out in thin layers, the bile presented a gamboge, yellow color.

Pancreas, normal.

Spleen, slate colored, softened and enlarged; not as much softened and altered, however, as in cases of malarial fever of longer standing. The mud of the spleen was of a dark purplish hue, and appeared to be in transition to the color and state of the mud of the spleens of malarial fever of longer duration. After exposure for a few hours to the oxygen of the atmosphere, a large portion of the mud of the spleen assumed a color approaching the arterial hue, much brighter than the mud of the spleens upon which malarial fever had exerted its full effects, and somewhat darker than the bright arterial hue assumed by the splenic mud of healthy, normal spleens. When the splenic mud was spread in thin layers upon a glass slide, the change of color was much more rapid. Under the microscope, the splenic mud appeared to consist almost entirely of colored corpuscles, many of which appeared swollen and altered in appearance. After careful examination, I was unable to find those conglomerations of black granules, resembling the black sediment of black vomit, which were discovered in other malarial spleens.

Kidneys, normal. Bladder contracted; contained no urine. Scrotum red, and apparently scalded. This was due most probably to the acrid urine. *I have observed this effect of the urine upon the scrotum in many cases of malarial fever of the severest types.*

Alimentary and Intestinal Canal.—The mucous membrane of the stomach presented two well-defined portions: the mucous membrane of the lesser curvature of the stomach was pale and normal in appearance; the mucous membrane of the greater curvature and pyloric extremity, and of the pylorus, was of a purplish color, and ecchymosed in crimson spots. The bloodvessels of the greater curvature and of the pylorus were congested with blood. Mucous membrane of the superior portion of the jejunum congested with blood. Valvulæ conniventes, especially at the edges, ecchymosed in spots of a purple and scarlet color. Mucous membrane of the lower portion of the ileum greatly congested with blood. Peyer's glands somewhat enlarged, more distinct and elevated than usual, but pale, and not congested and inflamed as in typhoid fever. Solitary glands enlarged and distinct. Mucous membrane of colon greatly congested with blood.

CONCLUSIONS.

1. The slight alteration of the color of the liver; the change of the blood of the liver to the arterial hue upon exposure to the atmosphere; the change of the splenic mud to the arterial hue—all prove that this patient had died very soon after the commencement of the malarial fever. As we have seen, the patient was unable to answer any inquiries with reference to the history of his case. So convinced was I that this was a case of only one or two days' standing, that I sought out the captain of the vessel to which this patient belonged, and made minute inquiries. The captain stated that this man was the cook on the vessel. One month ago, whilst the vessel was lying in the Santee River of South Carolina, this patient was taken with a fit. This was relieved in a few hours, and was not followed by fever; and the patient appeared to suffer no ill effects, and resumed his duties. Two weeks ago the captain brought his vessel to Savannah. This patient has been sleeping on board the ship at night up to the time of his entrance into the hospital. He was well, active, and attentive to his duties, up to 5 o'clock P. M., October 18, when he was suddenly seized with vomiting, cold extremities, complete prostration, and delirium. He

had cooked dinner this day, and was attending to his duties at the time of this sudden attack. He had, however, "a singular look out of his eyes," which attracted the attention of the captain, and led him to inquire if he was well; the patient answered yes, and complained of nothing. Whilst sick on board the ship, he complained of no pain; and, before the complete loss of reason, said that he felt well. The next day, the 19th inst., he was sent to the hospital at 5 o'clock P. M. I saw him for the first time at 8 o'clock P. M. He died at 12 o'clock M. the next day. *This patient, then, died after forty-three hours' sickness.*

2. The general and capillary circulations were easily aroused by stimulants; the temperature of the body, under the action of stimulants, was elevated above the normal standard; there was a correlation between the temperature of the trunk and extremities; the chemical changes appeared to be amply sufficient for the development of the muscular and nervous forces; and the liver and spleen had undergone comparatively but slight alterations. The most prominent apparent cause of death was the effusion of blood upon the base of the brain. The fit which occurred one month ago points to a previous derangement of the cerebro-spinal system.

Was the effusion of blood upon the brain the result of the action of the malarial poison alone, or the result of the action of the malarial poison upon the delicate structures of the brain already altered by previous disease? It is impossible to decide these questions positively, but all our observations upon malarial fever would lead us to accept the latter supposition. We regard the action of the malarial poison as depressing, and not inflammatory. Cerebral disturbances in malarial fever appear to be due—first, to the direct action of the malarial poison and of the altered blood upon the nervous structures; and, secondly, to the stagnation and accumulation of blood in the capillaries and bloodvessels of the brain, due to the diminished action of the heart, arrest and perversion of chemical change in the blood of the capillaries, and loss of power in the capillaries themselves. If by previous disease, arising of itself, or induced by the intemperate use of ardent spirits, the capillaries and bloodvessels of the brain and its membranes lose their tonicity, elasticity, and coherency, the simple stagnation and accumulation of blood may be attended by a rupture of the altered vessels, without any inflammatory action. A strong confirmation of these views is the fact that the vigorous administration of the most active stimulants, conjoined with sulphate of quinia, is the most efficient

mode of preventing, arresting, and relieving the coma and delirium of malarial fever. If the action of the poison was inflammatory, this would not be the case. The preceding case shows that we may have symptoms of inflammation of the brain in malarial fever, without a single pathological alteration after death, cognizable to the unaided senses.

We say *cognizable to the unaided senses*, because the thorough knowledge of the natuie of malarial fever demands, amongst many other things, a thorough knowledge, not only of the appearance and chemical constitution of the structures of the cerebro-spinal and sympathetic nervous systems, but also a thorough knowledge of the physical, chemical, and pathological alterations of these structures when acted upon by morbific agents.

We are actuated by no disparaging spirit, when we assert that in the present state of chemical, physiological, and pathological science, we are wholly ignorant of the chemical, physiological, and pathological relations of the malarial poison to the nervous elements.

In those cases in which the cause of death was not found in the pathological alterations of the organs and tissues, the question immediately arises, what destroyed life?

In the present state of medical science we can offer suppositions, but we can give no decided answer. *How difficult would it be to prove or disprove, that the malarial poison produced death by its direct action upon the nervous system, in a manner analogous to the action of some of the violent alkaloid and metallic poisons?* We know that some substances, as chloroform, will produce sudden death in some cases, when there is no assignable cause either in the structures and forces of the patient, or in the pathological alterations produced.

This peculiar action is said to be due to the idiosyncrasy of the patient. May not the fatal action of the malarial poison be due in some cases to the idiosyncrasy of the patient? Has any one ever determined upon what an idiosyncrasy depends?

3. A comparison of the autopsy of this case with that of previous cases shows that in the first stages of malarial fever the liver is first engorged with blood, and the slate and bronze color is not at first universal, but confined to definite portions. It is an interesting fact that in the present case the solitary glands were found enlarged even at this early stage of the disease. The mucous membrane of the stomach and intestines presented marks of congestion, if not of

inflammation. This condition of the mucous membrane is by no means characteristic of malarial fever, even when there is great tenderness upon pressure of the epigastrium. Tenderness here may be due rather to the state of the spleen and liver. The observation which we made upon previous cases is also true with regard to this, that the slate and bronze color of the liver is not due to the formation and distribution through the liver of peculiar dark-colored granules.

4. Although the stimulants and sulphate of quinia did not cure the disease, still they aroused the capillary and general circulation, and induced the chemical changes.

The following Tables, drawn up after the Careful Examination of Three Hundred Cases of Malarial Fever, will present a Comparative View of some of the most striking Phenomena of the Different Forms of Malarial Fever:—

INTERMITTENT FEVER.

COLD STAGE (CHILL).

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
1	Sept. 30	1 P. M.	Intellect clear; tongue clean, moist, red at tip and edges; papillæ enlarged, and of a bright red color; skin cool and relaxed; pulse feeble; saliva acid.	70	22	68.0°	92.0°	99.5°	Light orange color; sp. gr. 1010; reaction strongly acid; no deposit after standing 70 hours.
	" 30	5 P. M.	Extremities cold; head and trunk hot; pulse feeblo.	108	30	74.0	91.0	105.5	Do. do. do.
2	Oct. 10	12½ P. M.	Tongue pointed, but moist, and not much redder than usual; skin of extremities cold, of head and trunk hot, and presents a purplish mottled appearance; pulse small and feeble; saliva acid.	100	26	68.0	91.5	107.0	Urine excreted during the chill clear and limpid, of a light straw color; sp. gr. 1003; reaction strongly acid; slight deposit of triple phosphate after 60 hours.
	" 10	1 P. M.	Do. do. do.	100	26	68.0	87.5	107.0	Do. do. do.
3	" 14	..	Lips and fingers pale, and of a bluish color; extremities cold, whilst the trunk is hot; pulse small and feeble.	92	32	77.5	91.0	103.0	Urine excreted during the chill normal in color; sp. gr. 1023.
4	..	..	Shaking violently; lips and hands look blue; pulse small, feeble, and rapid; respiration full, panting, and irregular.	100	36–50	71.5	92.0	104.0	
5	..	..	Do. do. do.	..	..	79.0	90.0	102.0	
6	..	..	Do. do. do.	120	22	79.0	89.0	102.25	

HOT STAGE (FEVER).

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
7	..	..	Pain in bones of legs; slight tenderness of epigastrium; tongue clean, moist, red at tip and edges; papillæ red and enlarged; skin hot and dry; saliva acid; pulse full.	120	32	79.0°	103.3°	106.0°	Color of urine light orange; sp. gr. 1011; reaction strongly acid; no deposit after 60 hours.
	..	..	Do. do. do.	108	32	73.0	103.5	105.0	Color of urine normal; sp. gr. 1020; strongly acid.
8	..	..	Fever subsiding; pulse full, but soft; tongue moist; skin in a profuse perspiration.	98	..	72.0	102.5	103.0	Orange colored; sp. gr. 1025; clear; reaction strongly acid; no deposit after 60 hours.
	..	..	Skin hot and dry.	100	26	67.0	102.0	107.0	Specific gravity 1015.
9	Oct. 5	..	Skin hot, dry, and pungent to the hand; lips parched and dry; tongue dry and red; no tenderness of epigastrium; pulse full, strong, and bounding.	120	40	72.0	105.75	106.0	Light orange color; sp. gr. 1022; reaction strongly acid; no deposit.
10	Sept. 17	..	Chill just going off.	112	28	90.0	100.0	104.0	
	Oct. 3	..	Tongue red at tip, but moist and soft; skin hot and dry; saliva acid; pulse full and bounding; complains of pain in head.	100	26	77.0	105.0	106.0	Urine of a deep orange color, and decided acid reaction; sp. gr. 1008.
11	Aug. 18	..	Great thirst, and pain in head and back; tongue coated in the middle with yellowish fur, pointed and red at the sides and tip; skin hot and dry; pulse full and strong.	100	36	90.0	106.0	106.0	

INTERMITTENT FEVER—Continued.

HOT STAGE (FEVER)—Continued.

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
12	Sept. 11	..	Tongue slightly furred, not redder than normal; no tenderness of epigastrium; pulse full.	116	30	80.0°	102.5°	103.0°	Deep orange; sp. gr. 1018; reaction strongly acid; no deposit after 70 hours.
	" 12	..	Tongue moist and slightly furred; reaction of saliva acid; skin hot.	100	24	82.0	102.1	103.9	Orange colored; sp. gr. 1022.
13	" 7	..	Skin warm and moist; tongue slightly coated; no pain upon pressure of epigastrium.	108	24	82.0	103.7	105.0	Deep orange colored; sp. gr. 1020.8; after standing 39 hours, small deposit of urate of soda.
14	..	..	Skin hot and dry; pulse full; saliva acid.	108	28	85.0	104.0	105.0	
15	Oct. 3	..	Skin hot and dry; tongue red at tip, but moist and soft; pulse full and strong.	100	26	77.6	105.0	106.0	Reaction strongly acid; no deposit after standing several days.
16	July 8	..	Skin hot and dry; tongue dry; papillæ enlarged; tongue covered with thick yellow fur.	88	..	82.0	105.0	106.0	Deep orange color; after standing several days, slight deposit of mucus and vegetable cells.

INTERMISSION.

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
17	Sept. 30	1 P. M.	Skin cool and relaxed; pulse soft; tongue clean and moist, red at tip and edges; papillæ enlarged, and of a bright red color; reaction of saliva decidedly acid. This intermission was followed by high fever.	70	22	68.0°	92.0°	99.5°	Reaction of urine strongly acid; sp. gr. 1008; after standing 48 hours, a light deposit of vegetable cells, but no salts; orange colored.
	Oct. 3	..	Tongue clean and moist, only a shade redder than normal; papillæ still enlarged and distinct; saliva acid.	62	20	74.0	96.0	98.5	Urine normal in color; sp. gr. 1010; reaction slightly acid; in 20 hours changed to alkaline, and threw down a heavy deposit of phosphates and urate of soda.
	" 4	..	Tongue clean, moist, and soft; papillæ only a shade redder than normal; saliva acid.	60	20	72.0	96.0	99.5	Color normal; sp. gr. 1018; changed from acid to alkaline in 8 hours, and let fall a heavy precipitate of urates and phosphates.
18	" 13	..	Tongue and skin normal; saliva slightly acid; during the height of the fever, it was intensely acid. High fever three days ago.	68	16	78.0	98.0	99.0	Sp. gr. 1012; color normal; alkaline reaction, and heavy deposit of phosphates and urates in 12 hours.
19	" 7	..	Tongue clean and normal. Two days ago, had high fever.	64	20	73.0	94.5	99.0	Normal color; sp. gr. 1030; reaction alkaline in 16 hours, and heavy light-yellow deposit of urates and phosphates.
	" 8	..	Do. do. do.	52	24	73.0	98.2	99.5	Alkaline reaction, and heavy deposit in 14 hours.
20	Aug. 21	..	Two days before, had high fever. Tongue and skin moist.	72	17.5	80.0	96.0	98.0	Sp. gr. 1009; alkaline, and heavy deposit in 16 hrs.
21	Sept. 14	..	Had fever on the preceding day. Tongue and skin moist.	65	24	85.0	96.0	98.0	Sp. gr. 1021; alkaline, and heavy deposit in 20 hrs.

REMITTENT FEVER.

COLD STAGE (CHILL).

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
22	Oct. 9	..	Pulse very feeble, resembles the vibrations of a fine thread, with difficulty counted; respiration accelerated and irregular; lips and fingers blue; reaction of saliva intensely acid; extremities cold; tongue dry and red.	92	..	75.0°	83.0°	101.5°	High colored, like new Madeira wine; sp. gr. 1022; strongly acid; amount of iron increased; no deposit after 60 hours.
23	" 6	..	Respiration rapid, thoracic, panting; extremities cold; tongue dry, red, and rough; saliva strongly acid.	110	45	70.0	97.0	104.0	High colored, dark brownish red; strongly acid; sp. gr. 1020; iron increased; no deposit after 70 hours.

HOT STAGE (FEVER).

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
24	Sept. 10	7 P. M.	Tongue pointed and red at tip and edges, superior portion coated with black fur, dry and rough; skin hot, dry, and rough: great thirst, and pain in head; reaction of saliva strongly acid; pulse full.	90	48	80.0°	103.0°	105.0°	High colored, like new Madeira wine; sp. gr. 1020; iron increased.
	" 11	11 A. M.	Tongue red, dry, and glazed; skin dry, hot, and harsh; no pain of epigastrium; intellect dull; face as red as scarlet.	88	34–40	82.0	103.2	105.0	Reaction strongly acid; after standing 48 hours, threw down a small deposit of regularly-formed crystals of triple phosphates.
	" 11	7 P. M	Do. do. do.	90	40–44	81.0	104.0	104.8	Do. do. do.
25	Oct. 15	12 M.	Lips and tongue dry, red, and rough; epigastrium very tender upon pressure; skin dry and hot; pulse rather feeble; respiration full and irregular; intellect dull; saliva strongly acid.	106	30–40	74.0	101.0	105.0	Urine high colored, of a deep brownish red color; sp. gr. 1028; strongly acid.
26	..	..	Intellect torpid; aroused with difficulty; apex of tongue, for about half an inch, clean, red, and dry; the remainder of the tongue is coated with rough, dry, brownish-black and yellow fur; no tenderness of epigastrium; skin hot, dry, and rough.	90	30	74.0	105.0	106 0	Deep orange color; strongly acid; sp. gr. 1020; no deposit after 60 hours; still acid.
27	Sept. 16	7 P. M.	Face as red as scarlet; lies in a stupor; skin in a profuse perspiration; tip and middle of tongue clean, and of a bright red color; root of tongue coated with yellow fur; tongue rough and perfectly dry; when the finger is passed over the tongue, it feels as dry and as rough as a board; great tenderness upon pressure of epigastrium.	100	24	88.0	102.0	103.2	Unusual secretion of urine; the amount much larger than usual in remittent fever; specific gravity correspondingly diminished; orange colored; sp. gr. 1008; strongly acid; no deposit.
	" 18	12 M.	Tongue presents the same appearance; continues in a stupor; pulse feeble.	98	32	87.0	103.0	104.0	Light straw colored; sp. gr. 1010; reaction strongly acid.

REMITTENT FEVER—Continued.

HOT STAGE (FEVER)—Continued.

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
28	Aug. 7	11 A. M.	Skin hot, but in a profuse perspiration; tongue coated with yellow fur, dry and rough; lies in a stupor.	112	38	81.0°	103.0°	104.0°	Reddish-orange colored; sp. gr. 1013; reaction strongly acid.
	" 11	10 A. M.	Continues stupid, and almost insensible; passes urine and feces in bed; body has a peculiar, disagreeable smell; tongue coated and dry.	132	47	80.0	104.0	105.0	Urine normal in color; sp. gr. 1011.3.
			REMISSION.						
29	Sept. 12	12 M.	Tongue very red, but softer and moister than during the fever; the dry, yellow, and brown fur has commenced to clean off; slight tenderness of epigastrium.	70	26–36	83.0°	100.7°	102.5°	Urine high colored, brownish-red; sp. gr. 1019; reaction decidedly acid; after 48 hours, small deposit of vegetable cells, urate of soda, and triple phosphate.
	" 12	9 P. M.	Skin moist and relaxed; tongue softer and not so red; pulse regular and soft.	70	53	83.0	99 1	101.5	Brownish-red; sp. gr. 1020; strongly acid.
	" 13	11 A. M.	Tongue continues to improve.	52	48	85.0	97.0	100.0	Orange colored; sp. gr. 1024; reaction alkaline; heavy deposit of the urates and phosphates in 15 hours.
	" 14	1 P. M.	Tongue and skin normal.	58	28	87.0	99.0	102.0	Orange colored; sp. gr. 1025; reaction alkaline; heavy deposit of urates and phosphates in 15 hours.
30	Oct. 16	..	Intellect restored; tongue red, but soft and moist; skin dry, but soft; saliva strongly acid.	84	16	69.5	99.0	99.5	Deep orange red; strongly acid; after standing 15 hours, slight deposit of mucus corpuscles; after 100 hours, small light yellow deposit of mucus corpuscles, urate of ammonia, and vegetable cells.
31	" 16	12 M.	Tongue moister and softer, not so red as in fever; posterior portion still coated with brownish-yellow fur.	75	20	70.0	101.3	101.5	Bright red color; sp. gr. 1020; after standing 15 hours, slight deposit of urates and phosphates.
			INTERMISSION.						
32	Sept. 16	8 P. M.	Skin cool, moist and relaxed; tongue soft and moist, but slightly redder than normal.	47	28	87.0°	95.9°	99.0°	Shade higher colored than normal; after 12 hrs., heavy deposit of urates and phosphates; sp. gr. 1019.
	" 17	11 A. M.	Do. do. do.	44	24	84.0	96.0	99.0	Reaction alkaline in 16 hours, with heavy deposit of urates and phosphates; sp. gr. 1018.
	" 18	12 M.	Pulse, skin, and tongue normal.	44	24	86.0	96.2	99.0	Color normal; great increase of uric acid; in 8 hours, heavy deposit of urates and phosphates; sp. gr. 1020.
	" 19	12 M.	Do. do. do.	44	24	88.0	97.0	99.0	Do. do. do.
	" 22	12 M.	Do. do. do.	44	24	84 0	97.8	99.1	Do. do. do.
33	Oct. 17	12 M.	Tongue red, but clean and soft; saliva acid.	70	16	67.0	97.3	98.5	Deep red color; sp. gr. 1022.
34	" 17	11 P. M.	Tip of tongue clean, superior portion coated with fur.	68	18	68.0	98.0	99.5	Deep orange color; sp. gr. 1022.
35	" 8	12 M.	Tongue soft and moist; saliva acid.	54	18	68.0	96.0	99.0	Only a shade higher than normal; sp. gr. 1020.
36	Sept. 30	11 A. M.	Tongue red, but soft; intellect restored.	68	22	80.0	95.5	97.0	
	Oct. 1	11 A. M.	Do. do. do.	66	20	71.0	95.0	97.1	Orange colored; sp. gr. 1013.

CONGESTIVE FEVER.

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
37	Oct. 17	11 A. M.	Intellect wandering; tongue dry, hard, and rough, and coated with dry, brownish-yellow fur; pulse very feeble; skin cool upon trunk and extremities.	124	28	..	..	..	Clear amber colored; sp. gr. 1015; reaction strongly acid; after standing 60 hours, the reaction was still decidedly acid.
	" 18	11 A. M.	Intellect wandering; tongue continues still as dry and as rough as a board; pulse exceedingly feeble; trunk and head cold; skin covered with cold, clammy sweat; saliva strongly acid; respiration spasmodic; teeth coated with sordes.	155	34	..	..	..	The urine contained no urea, and no uric acid.
	" 18	9½ P. M.	Do. do. do.	135	32	..	..	..	After 90 hours, no deposit.
38	" 10	1 P. M.	Tongue perfectly dry and rough, feels like sand-paper; bright red color.	130	46	68.5°	100.0°	106.0°	
	..	..	Severe vomiting and purgation; skin of head and extremities bathed in cold clammy sweat.	94	22	71.0	79.0	97.0	Urine light colored; sp. gr. 1020; urea and uric acid greatly diminished; reaction strongly acid.
39	Aug. 21	1 P. M.	Severe pain in head; tongue thickly coated with yellow and black fur, tip and edges clean, and of a scarlet color; dry and rough.	92	39	80.0	89.0	97.0	
	" 22	12 M.	Do. do. do.	112	52	81.0	99.0	104.0	
	" 23	12 M.	Do. do. do.	72	34	78.0	89.0	96.0	
40	" 26	12 M.	Pulse very feeble; skin of trunk and head cool; tongue dry, rough, and coated.	120	22	71.0	95.5	98.0	Urine orange colored, several shades higher than in health, but much less highly colored than usual in severe cases of malarial fever; sp. gr. 1009; contained no uric acid.
	" 27	12 M.	Do. do. do.	120	24	87.0	98.0	98.5	Do. do. do.
	..	7 P. M.	Do. do. do.	140	40	83.0	90.0	97.0	Do. do. do.
41	Sept. 29	11 A. M.	Tongue slightly coated with yellow fur, dry and harsh to the feeling; intellect stupid; pulse very feeble, with difficulty counted.	112	18	80 0	95.1	97.0	
	..	7 P. M.	Do. do. do.	140	34	..	..	..	Bright red color; sp. gr. 1016; strongly acid.
	Sept. 30	2½ P. M.	Do. do. do.	112	17	73.0	91.0	96.0	Do. do. do.
	Oct. 1	2 P. M.	Restless and stupid; tongue the same.	100	16	79.0	88.5	94.5	Do. do. do.
	" 4	2 P. M.	Do. do.	120	24	76.0	100.5	..	Do. do. do.
	" 5	2 P. M.	Restless and stupid; skin hot, dry, and rough.	118	24	73.0	100.0	104.0	Do. do. do.
	" 10	4 P. M.	Do. do. do.	130	28	70.0	103.7	104.5	Do. do. do.

CONGESTIVE FEVER—Continued.

No. of case.	Date.	Hour of day.	State of Intellect, Skin, Tongue, Pulse, Respiration, &c.	Pulse.	Respiration.	Temperature of atmosphere.	Temperature of hand.	Temperature under tongue.	Characters of Urine.
42	Sept. 3	12 M.	Tongue red, dry, and rough; skin of extremities and trunk cold.	140	28	75.0°	94.5°	99.0°	Could not be determined on account of restlessness and stupor of the patients.
	..	3½ P. M.	Lies with mouth and eyes open, and is insensible; skin in a profuse perspiration.	128	33	78.0	101.0	102.0	
	Sept. 4	12 M.	Skin covered with a clammy sweat, resembling bloody serum; passes urine and fœces in bed.	106	26	81.0	100.0	101.0	
	" 5	10 A. M.	Lies in a stupor, and emits a barking sound; muscles of body twitching violently.	144	42	79.0	103.0	104.0	
	" 6	10 A. M.	Do. do. do.	140	38	80.0	105.0	106.0	
43	..	..	Lies in a profound stupor; great tenderness of epigastrium; skin dry and rough.	140	40	70 0	104.0	104.5	
44	Oct. 12	12 M.	Intellect wandering; pulse feeble; tip of tongue clean and of a bright red color, the remaining portion coated with yellow fur, dry, rough, and harsh as sand-paper.	137	32	..	..	..	
	" 13	11 A. M	Do. do. do.	144	30	77.0	103.5	104.5	
45	Sept. 3	12 M.	Intellect wandering; delirious and violent; tongue coated and dry; pulse feeble; respiration thoracic; skin dry.	140	36	75.0	102 0	104.0	
	" 3	3 P. M.	Do. skin in a profuse perspiration.	130	36	80.0	98.0	99.0	
	" 3	7 P. M.	Do. do. do.	120	32	76.0	94.0	98.0	

The next subjects which demand investigation are—

1. The comparison of the circulation, respiration, temperature, and chemical changes of the solids and fluids, especially of the urine in malarial fever, with similar phenomena in health, and in all other diseases.

2. The action of the medicines employed in the treatment of malarial fever.

3. The comparison of the methods and results of treatment in malarial fever with those of other diseases.

4. Nature of the causes of malarial fever.

5. Relations of malarial fever to soil, water, atmosphere, and climate.

The discussion of each one of these divisions would occupy as much space as the preceding imperfect investigation, and must, therefore, be deferred to a future time.

In concluding these "Observations on some of the Phenomena of Malarial Fever" (which have been the result of three years' labor and study, upon more than three hundred cases of the different forms of malarial fever, in Savannah, in Liberty County, in Athens, and in Augusta), we would again admit that they are incomplete —in fact, nothing more than beginnings in the right direction— and again express the hope that the statements, and relations, and laws deduced from these observations, will be tested by careful, conscientious observers; the errors eliminated, the imperfections removed, the results enlarged, and the positive knowledge of the phenomena of malarial fever, and of all fevers, established by observation, experiment, and reason.

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